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**TECHNICAL WHITE PAPERS 3 & 4:
ADAPTIVE MANAGEMENT AND MONITORING STRATEGY FOR
THE CITY OF SAN DIEGO
VERNAL POOL HABITAT CONSERVATION PLAN**

Prepared for:

San Diego Association of Governments
401 B Street, Suite 800
San Diego, CA 92101
Phone: (619) 699-1951

Prepared by:

AECOM
1420 Kettner Boulevard, Suite 500
San Diego, CA 92101
Phone: (619) 233-1454

Primary Authors:

Lindsey Cavallaro, Scott McMillan, Tom Oberbauer, and Linnea Spears-Lebrun

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CHAPTER 1

INTRODUCTION

1.1 PROJECT OVERVIEW

The San Diego Association of Governments (SANDAG) will prepare a Vernal Pool Habitat Conservation Plan (HCP) for the City of San Diego (City) largely based on information contained in a series of Technical White Papers (TWPs). The Planning Area for the HCP is the geographical extent of land that will be included in the HCP and for which the protections provided under the HCP are afforded to the seven focal species. For the City's HCP, these lands include the entire jurisdictional boundaries of the City and three areas owned by the City's Public Utilities Department in the unincorporated portion of San Diego County (County). The Planning Area's extent is, by design, the area covered by the City's Multiple Species Conservation Program (MSCP); the HCP is a separate but compatible conservation plan for vernal pools and seven threatened and/or endangered focal species not covered under the City's MSCP.

Many lands included in the Planning Area are not under the local land use jurisdiction of the City. These lands could include special districts such as school districts, military lands, other federal properties, and state lands. The regulatory requirements of the HCP are not applicable to lands outside the City's jurisdiction. If land ownership is transferred and subsequently comes under the City's jurisdiction, or if the owner voluntarily requests inclusion, the HCP regulatory requirements will be applied after undergoing the appropriate amendment process, as outlined in the HCP.

The TWPs focus on seven target vernal pool species consisting of five plants and two crustaceans:

- Otay Mesa mint (*Pogogyne nudiuscula*)
- San Diego Mesa mint (*Pogogyne abramsii*)
- Spreading navarretia (*Navarretia fossalis*)
- San Diego button-celery (*Eryngium aristulatum* var. *parishii*)
- California Orcutt grass (*Orcuttia californica*)
- Riverside fairy shrimp (*Streptocephalus wootoni*)
- San Diego fairy shrimp (*Branchinecta sandiegonensis*)

The eight TWP topics are as follows:

- TWP 1: Focal Species Status Update in the City of San Diego
- TWP 2: Assessment of Focal Species Conservation
- TWP 3: Development of Adaptive Management Strategy
- TWP 4: Development of Monitoring Strategy
- TWP 5: Property Analysis Record
- TWP 6: Recommendations for Conditions of Coverage
- TWP 7: Conservation Analysis
- TWP 8: Preserve Management Funding Mechanisms

This combined document represents TWPs 3 and 4. The purpose of this document, referred to herein as the City of San Diego Vernal Pool Management and Monitoring Plan (VPMMP), is to provide management and monitoring strategies, directives, and recommendations for all lands containing vernal pools in the vernal pool HCP Preserve in order to preserve and/or restore their biological components, particularly the seven focal threatened and endangered species. It provides an update to the City of San Diego's Draft Vernal Pool Management Plan (VPMP) (2009).

1.2 BACKGROUND

Following adoption of the City's Multiple Species Conservation Program Subarea Plan (City of San Diego 1997), the City developed a draft VPMP to provide direction for City-owned vernal pool complexes. The City's current Draft VPMP (2009) developed the Coordinated Management Program to improve resource management among internal departments in response to City-wide issues. Individual sites were also discussed in detail, including existing conditions and biological reports, threats, current management activities, and specific recommendations. The document has subsequently provided guidance for land managers and others concerned with the conservation of San Diego vernal pools. This VPMMP develops an updated approach to adaptive monitoring and management for the City's HCP Preserve. The VPMMP also updates site conditions, provides more current guidance for management, and identifies specific management objectives at each of the 56 vernal pool complexes¹ in the Preserve.

¹ Vernal pool complexes may include two to several hundred individual vernal pools (Keeler-Wolf et al. 1998). Typically, the pools in a complex are connected through the landscape, including the supporting watershed and upland habitats. These vernal pool complexes were given identification numbers by Bauder (1986). The numbers were updated by the City of San Diego's Vernal Pool Inventory (2004) and again updated by SANDAG (2011).

The strategies, directives, and recommendations in this document reflect adaptive management principles. Adaptive management is a multi-step process and generally includes the following elements (Figure 1-1):

- Defining management objectives
- Initial monitoring to determine baseline relative to that objective
- Implementing management actions
- Subsequent monitoring to observe the results of those actions
- Use results to adjust management actions
- Repeat monitoring and management

1.3 GOALS AND OBJECTIVES

An objective of the VPHCP is to “implement species-specific and habitat-based goals and objectives for the protection of vernal pool species.” The following goal and objectives have been identified with the assistance of the U.S. Fish and Wildlife Service (USFWS) and California Department of Fish and Game for the VPMMP. These goals are consistent with the USFWS Recovery Plan (1998) and other vernal pool management documents that have been prepared by the City of San Diego (2009). However, the goals and objectives in this document have been updated to address the most recent knowledge of vernal pool habitat conditions and lessons learned regarding vernal pool habitat monitoring and management in the last 10 years.

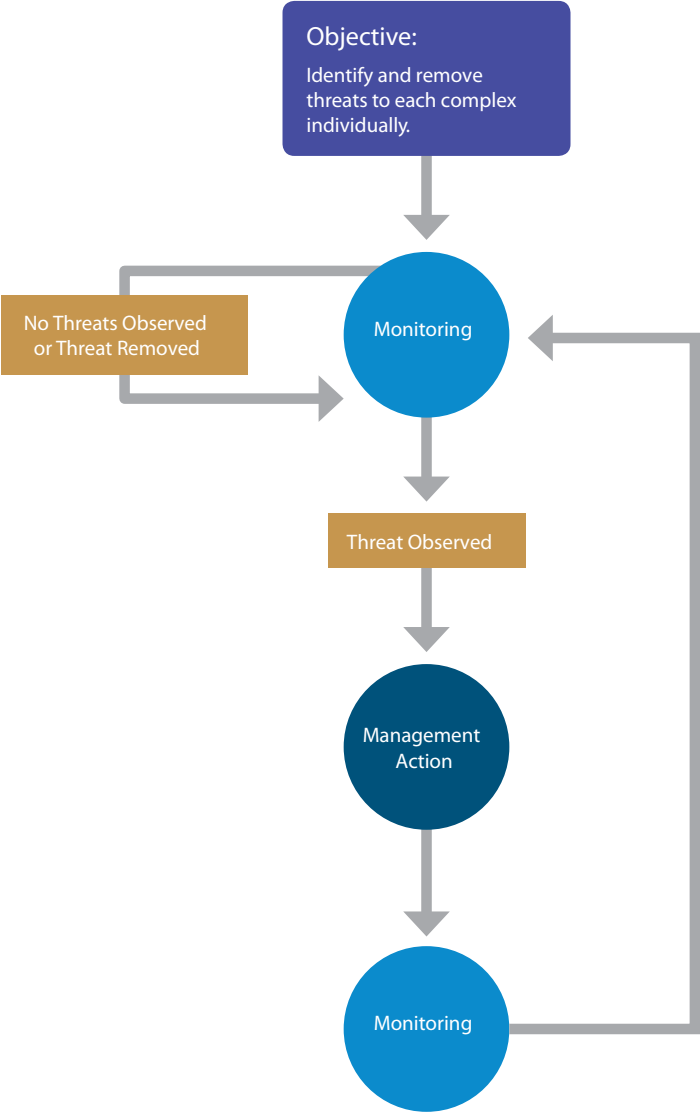
1.3.1 Biological Goal of the VPMMP

Maintain, stabilize, and remediate the integrity of conserved vernal pools and the focal vernal pool species populations identified in the VPHCP by implementing the objectives below.

1.3.2 Vernal Pool Habitat Objectives

1. Maintain and enhance diversity of focal species within vernal pool complexes in the VPHCP Preserve.
2. Reduce threats within the watersheds, including weeds, artificial changes in hydrology, and anthropogenic impacts.

Figure 1-1 Overview of Adaptive Approach to Monitoring and Management



1.3.3 Species-Specific Objectives

Otay Mesa Mint

1. Protect and manage existing vernal pool complexes and their associated watersheds currently occupied by Otay Mesa mint within the Preserve (J2, J4-5, J14 [specifically Cal Terraces South], J15, J29, J30, and J32) to maximize the likelihood that existing occurrences are sustained in the VPHCP Plan area and, in doing so, contribute to recovery of the species on a range-wide basis.
2. Conserve, establish, and manage vernal pool habitat and Otay Mesa mint to baseline structure and composition within at least eight complexes, with consideration toward J13, J14, and J16-18, to increase genetic diversity and population stability of Otay Mesa mint.

San Diego Mesa Mint

1. Protect and manage extant populations across the range of existing vernal pool complexes and their associated watersheds currently occupied by San Diego mesa mint within the Preserve to maximize the likelihood that existing occurrences are sustained in the VPHCP area, and, in doing so, contribute to recovery of the species on a range-wide basis.

Spreading Navarretia

1. Protect and manage existing vernal pool complexes and their associated watersheds currently occupied by spreading navarretia within the Preserve (D5-8, J2, J4-5, J15, J16-18, J32, J33, K5, and X5) to maximize the likelihood that existing occurrences are sustained in the Plan area and, in doing so, contribute to recovery of the species on a range-wide basis.
2. Conserve, establish, and manage vernal pool habitat and spreading navarretia to baseline structure and composition within at least five complexes, with consideration toward J13N, J14, J29, J30, N5-6, and R1 to increase genetic diversity and population stability of spreading navarretia.

San Diego Button-Celery

1. Protect and manage extant populations across the range of existing vernal pool complexes and their associated watersheds currently occupied by San Diego button celery within the Preserve to maximize the likelihood that existing occurrences are sustained in the

VPHCP area, and, in doing so, contribute to recovery of the species on a range-wide basis.

California Orcutt's Grass

1. Protect and manage existing vernal pools and their associated watersheds currently occupied by Orcutt's grass complexes within the Preserve (J2, J4-5, and J14 [specifically Cal Terraces South]) to maximize the likelihood that existing occurrences are sustained in the Plan area, and, in doing so, contribute to recovery of the species on a range-wide basis.
2. Conserve, establish, and manage vernal pool habitat and Orcutt's grass to baseline structure and composition within at least 11 complexes, with consideration toward J11E, J11W, J12, J13E, J13N, J13S, J14, and J16-18 to increase genetic diversity and population stability of Orcutt's grass.

Riverside Fairy Shrimp

1. Protect and manage existing vernal pool complexes and their associated watersheds currently occupied by Riverside fairy shrimp within the Preserve (J2, J4-5, J11W, J14 [including Cal Terraces South], J15, J16-18, J30, J31, J32, and J34) to maximize the likelihood that existing occurrences are sustained in the VPHCP area, and, in doing so, contribute to recovery of the species on a range-wide basis.
2. Conserve, establish, and manage vernal pool habitat and Riverside fairy shrimp to baseline structure and composition within at least four complexes, with consideration toward J11E, J12, J13E, and J36, to increase genetic diversity and population stability of Riverside fairy shrimp.

San Diego Fairy Shrimp

1. Protect and manage extant populations across the range of existing vernal pool complexes and their associated watersheds currently occupied by San Diego fairy shrimp within the Preserve to maximize the likelihood that existing occurrences are sustained in the VPHCP area and, in doing so, contribute to recovery of the species on a range-wide basis.

1.4 VPMMP STANDARDS

To meet the goals and objectives of the VPMMP, the following standards will be implemented and monitored to assess the status and need for complex-specific management actions. These standards were developed using the “SMART” method (Adamcik et al. 2004). These standards will be implemented through complex-specific management and monitoring directives identified in Appendix A.

These standards will be used to assess all vernal pools monitored under the tiered adaptive monitoring and management approach described below, and to assess the success of complex-specific management actions.

- a) Annually identify threats (invasive species, trampling, off-road-vehicle [ORV] activity, etc.) in all pools monitored, and implement actions to prevent or reduce those threats.
- b) Prevent an average decline of at least one cover class of any focal plant species over 3 years for years having at least 65% average rainfall.
- c) Prevent a 20% decline in the density of the focal shrimp species over 3 years.
- d) Prevent an increase in one cover class for nonnative cover over 3 consecutive years, regardless of rainfall. This trigger only applies to complexes having an average of 10% or more total nonnative species cover.

1.5 VPMMP OVERVIEW

The VPMMP uses a three-tiered approach to adaptive monitoring and management that is applied to individual vernal pool complexes. Adaptive management is an iterative process of learning about a resource through monitoring, and then making decisions to optimize management of that resource to achieve specific objectives.

Focal species populations are evaluated at a complex level. The three tiers are linked to the VPMMP goals and are assigned to a complex based on existing habitat conditions and focal species population status of the seven focal species within a complex. The goals of the monitoring and management levels within each complex are:

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- Level 1 – *maintain* existing habitat conditions and existing focal species population status
 - Level 2 – *stabilize* focal species population status by improving habitat conditions to a level that can support existing populations
 - Level 3 – *remediate* declining focal species population status by improving habitat conditions to a level that can support baseline (defined below) focal species populations

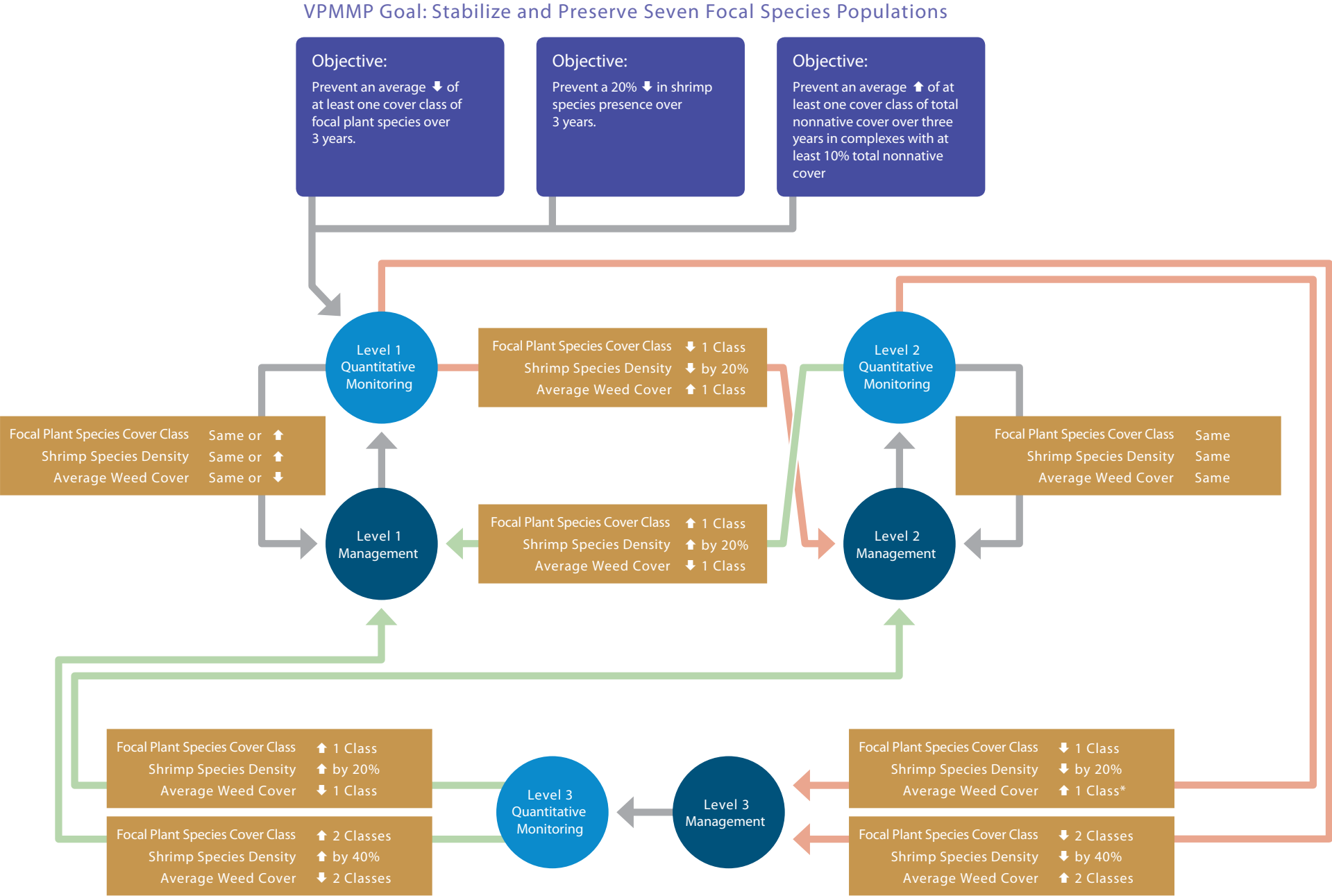
Adaptive monitoring and management actions are determined based on triggers directly tied to the objectives above, and implemented on a complex-wide basis. Figure 1-2 shows the required level of monitoring and management required based on these triggers. Each level applies to a particular population condition within a complex. For example, a population within a particular complex that is stable or increasing will be *maintained* in that condition, requiring the least monitoring and management effort (Level 1). But a population within a particular complex that is declining considerably will need *remediation*, which requires the highest level of monitoring and management effort (Level 3). The City’s 2004 Vernal Pool Inventory (City of San Diego 2004) will serve as the baseline for comparison to maintenance triggers for each complex. In situations where more recent data exist, the more recent data will be used as the baseline for comparison to the maintenance triggers.

Specific details on monitoring methods, maintenance activities, and the triggers can be found in Chapters 2 through 4. Chapter 2 describes the necessary monitoring methods used for each level of monitoring. Chapter 3 describes the triggers for management actions based on the data collected during monitoring. Chapter 4 details the necessary management actions to be taken based on the triggers for each level of maintenance. Necessary actions are those that are required to conserve and protect populations of each of the seven focal species under the HCP.

Chapter 5 contains a description of “desired” actions to achieve the fourth goal, which is to expand the habitat conditions and focal species populations within a complex. Desired actions are those that may require additional research to implement, including actions that are necessary to expand the populations of each of the focal species. Where appropriate, desired actions will be implemented via grants or other types of alternative funding sources.

Attachment A of the VPMMP provides the following information for each vernal pool complex within the HCP Preserve:

Figure 1-2 Tiered Adaptive Monitoring and Management Approach



*Or complex remains at Level 2 for three consecutive years.

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- Site Description and Existing Conditions, including summarizing of biological resource data on the seven focal species and other key existing condition information based on the City's Vernal Pool Inventory (2004) and data in the City's vernal pool database (2011). Per the terms of the HCP planning agreement, no new vernal pool surveys were conducted to prepare the VPMMP.
 - Current and Potential Threats to the complex by development, invasive species, edge effects, fire and fire suppression, illegal access (ORV, trails, etc.), and other issues specific to each complex.
 - Current Management Activities and Management Recommendations for the City or other site managers. This could include fencing and signage, weed control, topographic reconstruction, seed or cyst collection/bulking/inoculation, and other types of management activities. The recommended management level for each of the 56 complexes in the HCP Preserve is identified, along with specific management recommendations for each complex. The management recommendations for complexes J N, J S, and J W are combined in Attachment A due to overlap of specific vernal pool site names within these three complexes.

CHAPTER 2

TIERED MONITORING APPROACH

2.1 MONITORING INTRODUCTION

The VPMMP monitoring methods and sampling design focus data collection on data required to determine if the objectives of the program (listed in Section 1.3) are being met. This allows for time- and cost-effective monitoring that evaluates and adaptively revises management actions based on management triggers (Chapter 3). The VPMMP monitoring program evaluates the seven focal species populations within each complex of the HCP Preserve. The methods are designed to be implemented by qualified City staff with minimal input from vernal pool experts.

2.2 VPMMP TIERED MONITORING APPROACH

The tiered monitoring approach requires both qualitative and quantitative monitoring at vernal pool complexes within the HCP Preserve. Monitoring will be performed on City-owned lands that are under the City's land use jurisdiction.

Qualitative monitoring corresponds to documenting observations during periodic site visits. For all monitoring levels, qualitative monitoring will occur at each complex to identify and document threats to the complex, such as invasive plants, dumping, ORV activity, and trampling.

Quantitative monitoring involves activities such as mapping and estimation of species cover, population size/density, and presence/absence at each complex. Quantitative monitoring requirements vary based on the three levels of monitoring, with higher levels collecting more data with greater precision to inform management actions. More data collection requires greater effort and cost. The decision to move to a higher monitoring level is based on triggers directly tied to the objectives stated in Chapter 1. More detail on the triggers can be found in Chapter 3.

Table 2-1 provides an overview of the sample size and monitoring methods for each level of monitoring. More detail is provided regarding the monitoring methods (Section 2.2.1 Qualitative and 2.2.2 Quantitative), as well as the approaches associated with each of the three monitoring levels (Sections 2.2.2.1 through 2.2.2.3).

**Table 2-1
Tiered Monitoring Approach**

Level	Sample Size	Frequency and Timing	Monitoring Method
Qualitative			
	All Complexes	Three visits annually, during wet season	Threat assessment and pool inundation verification
Quantitative			
Level 1	10% of pools in each complex with focal plant species If complex has <10 pools for each focal species, survey at least one pool for each focal species known to occur	Annually, spring	Collection of cover class data of each focal plant species and each nonnative plant species
	Up to 10 pools or 5% of pools with focal shrimp species, whichever is greater	Every 3 years, dry season	Dry season sampling with genetic identification of cysts
Level 2	All pools in complex with focal plant species	Annually, spring	Collection of cover class data of each focal plant species and each nonnative plant species
	Up to 10 pools or 10% of pools with focal shrimp species, whichever is greater	Every 3 years, dry season	Dry season sampling with genetic identification of cysts
Level 3	All pools in complex with focal plant species	Annually, spring	Collection of cover class data of all native plant species and each nonnative plant species
	Up to 10 pools or 20% of pools with focal shrimp species, whichever is greater	Every 3 years, dry season	Dry season sampling with genetic identification of cysts

2.2.1 Qualitative Monitoring

Regardless of the designated monitoring level, annual qualitative monitoring will be conducted at each applicable vernal pool complex within the HCP Preserve (Attachment A). This includes complexes on lands that the City owns and under the City's land use jurisdiction (where legal access is available). General site assessment information will be collected, including current or potential threats (invasive species, edge effects, fire, and others), and recommendations for management will be generated.

Each complex will be assessed for the following conditions and threats:

- Fencing and Signage: The conditions of fencing or other site protection measures will be checked to verify that the site is secured and appropriate signage is in place.

-
- Edge Effects: Each complex will be inspected for edge effects from landscaping (irrigation runoff, invasive species, herbicide application, etc.), water drainage (water quality, increased ponding, etc.), dust production, and other issues within the complex or on adjacent properties.
 - Fire and Fire Suppression: Evidence of fire or disturbance from fire suppression will be evaluated for impacts to the site (loss of native habitat, weed invasion, erosion, etc.).
 - Trespass: Each complex will be inspected for signs of trespass or illegal ORV activity.
 - Topographic Disturbance: Each complex will be evaluated for topographic disturbance from vehicle damage, illegal trespass, or other landscape damaging impacts.
 - Invasive Species: A general assessment of nonnative plant and animal invasion will be made during each qualitative survey for both the vernal pool and upland areas. Observations of invasive plant species and invasive wildlife presence will be noted.
 - Inundation: A visual check for pool inundation will be performed; inundation of at least 3 centimeters (cm) in depth will be noted.

The qualitative monitoring described above will be conducted every year regardless of the level of rainfall received. Visits should occur in the winter and spring seasons (January 31 through May 31). This monitoring can be conducted in conjunction with the quantitative monitoring described below. A combined monitoring form for both qualitative and quantitative data that will be used for data collection is included as Attachment B.

In addition to an annual threat assessment, each vernal pool complex with focal shrimp species will be visited up to three times a year during the wet season to check for pool inundation. These visits should be timed to occur following a large rain event when inundation of the pools is expected. Inundation of at least 3 cm in depth will be noted.

2.2.2 Quantitative Monitoring

Regardless of the assigned monitoring level, each applicable complex within the Preserve will have some quantitative monitoring conducted each year. Surveys should be timed to coincide with the appropriate ecological conditions for the target species. For the focal plant species, timing should coincide with the optimal flowering time later in the season when detection and identification of both early and late vernal pool plant species are possible. For the focal shrimp species, cyst collection visits should occur during the dry season.

The monitoring level will determine whether only the focal plant species will be assessed or whether all of the plant species in the pools (with focal species) will be assessed. Monitoring will include cover estimates using cover classes taken from the California Native Plant Society's (CNPS) plant cover methodology. The City began using the CNPS cover class methodology in 2006 to collect data on vernal pools following the McEachern et al. MSCP rare plant monitoring protocol. This methodology was also used during the Vernal Pool Inventory of the City's vernal pool complexes (City of San Diego 2004). With this methodology, estimated absolute percent cover of each focal plant species in a pool is grouped in the following classes to track changes in cover over time: <1%, 1–5%, 5–10%, 10–25%, 25–50%, 50–75%, and 75%+. Use of the CNPS class system allows for valuable data collection without the time required for other types of vegetation assessments (transects, plot-frames, etc.). In addition to the focal plant species, other native and nonnative vegetative cover can be estimated with the CNPS class system. More detail on this method is provided below under each of the monitoring levels.

For the focal shrimp species, dry season sampling of cysts with genetic identification to species will be used. Monitoring for floral and faunal components should be conducted entirely from the pool margins so that trampling of vernal pool resources and the inadvertent transferring of vernal pool propagules (plant seeds and shrimp cyst) are minimized.

These methods can be revised if new or improved methods are established. However, it is important that any new methods provide comparable data for evaluating the success of the VPMMP and for long-term trend evaluations. The new methods should also be comparable in cost.

2.2.2.1 Monitoring Level 1

Monitoring Level 1 includes all aspects of the qualitative monitoring described above, as well as quantitative monitoring for a subset of the focal species vernal pools at each applicable complex in the Preserve (Attachment A). At Monitoring Level 1, 10% of the vernal pools with focal plant species will be assessed quantitatively using the CNPS class system described above. If a complex has less than 10 pools for a particular focal species, survey at least one pool for each focal species known to occur. Only the focal species will be assessed in each pool. Pools in a given complex with more than one focal species will be preferentially chosen to reduce the total number of pools required for sampling. These intentionally chosen pools are considered sentinel pools. If 10% of the pools in a complex containing each focal plant species cannot be sampled in the same pools, the remaining needed pools will be chosen randomly in each complex. The sentinel pools as well as the randomly chosen pools would then be sampled every year to provide greater precision in changes observed in cover class estimates. While not random, the use of

sentinel pools with multiple focal plant species, as well as the use of permanent sampling, will increase the efficiency and precision of monitoring at Level 1.

The following is a hypothetical example that demonstrates the application of the 10% sample size and sentinel/random pool selection methods. Table 2-2 also details this example. A complex is known to contain 100 pools. Of those, 30 pools have San Diego button-celery, 20 pools have San Diego mesa mint, and five pools have spreading navarretia. Some pools contain more than one focal species. Based on the 10% rule, 3 of the 30 San Diego button-celery pools, 2 of the 20 San Diego mesa mint pools should be monitored. One of the five spreading navarretia pools in this complex should be monitored, since fewer than 10 pools have this particular focal plant species. If two pools in the complex contain all three species, these two pools would be preferentially chosen to be monitored and serve as sentinel pools. A third pool containing San Diego button-celery would be chosen randomly from the 30 pools known to contain San Diego button-celery to complete the required monitoring at this example complex. In this hypothetical monitoring year, three pools would fulfill the requirement for monitoring under Level 1 and these three pools would then be sampled every year that this hypothetical complex is at Monitoring Level 1.

Table 2-2
Monitoring Level 1 Example Vernal Pool Complex Sampling Selection

Complex Characteristics	Number of Pools	Sample Size (10% or at least 1 pool if <10 pools)	Permanent Pool Selection¹
San Diego button-celery pools	30	3	1 [Randomly select one additional pool from these 30 to satisfy requirement for 3 total San Diego button-celery pools]
Otay mesa mint pools	20	2	-
Spreading navarretia pools	5	1	-
Pools with no focal species	45	-	-
Number of pools out of 100 with all 3 focal plant species	2	-	2 [Preferential selection of these two sentinel pools would satisfy sample size requirements for Otay mesa mint and spreading navarretia and 2 of 3 San Diego button-celery pools].
TOTAL	100	6	3

¹ Pools for permanent sampling will be selected for each complex the first year a complex is part of Monitoring Level 1.

At Monitoring Level 1, nonnative species cover will be assessed using the CNPS class system; however, all nonnative species will be aggregated into one cover class estimate for comparison to the triggers.

For the two focal shrimp species, monitoring will include dry season sampling for shrimp cysts that will be genetically identified to species. For Monitoring Level 1, 5% of the pools at each complex with the focal shrimp species will be sampled once every 3 years.

An estimate of density for each focal shrimp species can be calculated as the number of cysts per volume of soil. The change in density can be tracked over time as an indicator of the population size of the pool. If the average cyst density decreases across the occupied pools in a complex, it can be inferred that the focal shrimp population is decreasing at that complex. Similarly, if the average cyst density increases across the occupied pools in a complex, it can be inferred that the population is increasing at that complex.

2.2.2.2 Monitoring Level 2

At Monitoring Level 2, pools with focal plant species will be assessed quantitatively using the CNPS class system. Pools without focal species will not be assessed, and only the focal species will be assessed for each pool.

At Monitoring Level 2 nonnative species cover will be assessed using the CNPS class system described for the focal species; however, all nonnative species will be lumped into one cover class estimate for comparison to the triggers.

For the two focal shrimp species, San Diego fairy shrimp and Riverside fairy shrimp, the monitoring for shrimp cyst density will be the same as in Monitoring Level 1. However, 10% of the pools at each complex with the focal shrimp species will be sampled every 3 years

2.2.2.3 Monitoring Level 3

Monitoring Level 3 includes all aspects of the qualitative monitoring described above, as well as quantitative monitoring for all complexes in the Preserve assigned to Management Level 3 in Attachment A (i.e., remediation). For Monitoring Level 3, monitoring will occur only in pools with the focal species. However, the assessment will include all plant species occurring in those pools, including native (endemic vernal pool plants and upland species) and nonnative plant species.

For the two focal shrimp species, San Diego fairy shrimp and Riverside fairy shrimp, the monitoring for shrimp cyst density will be the same as in Monitoring Level 1 and Level 2. However, 20% of the pools at each complex with the focal shrimp species will be sampled every 3 years.

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CHAPTER 3

MANAGEMENT ACTION TRIGGERS

3.1 MANAGEMENT ACTION TRIGGERS INTRODUCTION

The tiered monitoring program described in Chapter 2 will be used to evaluate site conditions in individual pools with focal species in each applicable complex within the HCP Preserve to determine the appropriate monitoring and management level.

In general, rainfall amounts will determine whether the vernal pool flora and fauna are expressed adequately enough to determine focal species population status. The benchmark for annual survey assessments comparable to the triggers will be a percentage of the average rainfall for San Diego, as recorded at three weather stations throughout San Diego County, as detailed in Table 3-1.

Table 3-1
Weather Station and Average Rainfall Information

Region	Regional Transportation and Precipitation Station	Average Rainfall (Year Range)	Two-Thirds of Normal Rainfall (July through June)
North	Oceanside Harbor	10.63 inches (1909 through 2010)	6.91 inches
Central	San Diego Lindbergh Field	10.18 inches (1914 through 2010)	6.82 inches
South	Chula Vista	9.75 inches (1918 through 2010)	6.34 inches

It has been suggested that two-thirds of normal rainfall should be considered the minimum to express the full ecological parameters required for many systems (Bauder 2000). For the VPMMP, the minimum rainfall required for adequate assessments is two-thirds of normal rainfall for the appropriate region for the period of July through June. The 65% of average rainfall years do not have to be sequential. Quantitative monitoring will be conducted annually, regardless of rainfall; however, only those years with 65% average rainfall will be compared to the triggers described below.

3.2 QUALITATIVE THREAT TRIGGERS

As discussed in Chapter 2, regardless of the monitoring level for a complex, qualitative monitoring will be conducted at each applicable complex in the Preserve (see Attachment A) to collect general site assessment information. The general existing conditions will be assessed, as well as current or potential threats (development, invasive species, edge effects, fire, and others); recommendations for management will then be made for City staff land managers to implement. Assessments will be conducted and utilized regardless of rainfall amounts.

The qualitative assessments will be compared to the qualitative threshold triggers defined below. These triggers are more subjective than those that are tied to the quantitative triggers; because of this, management will be more flexible. Any problems noted during qualitative assessment should be addressed immediately (or after pools have dried, to avoid damage), regardless of the time of year, the other types of management recommended for the site, or the results of quantitative monitoring.

Fencing and Signage

If, during a qualitative assessment, problems are identified with site protection measures (such as gaps cut in fencing or barriers, locks destroyed, signage damage or removal), recommendations will be made to address the issues (e.g., repair fencing, replace signs).

Edge Effects

If issues with edge effects are documented, recommendations will be made to the City or land manager to address the problem. This may include changes to irrigation designs or schedules, modification of landscape species, erosion control measures, dust suppression measures, and other adaptive efforts. If problems are being caused by adjacent land use and management, the City or land manager will contact adjacent property owners/managers to address the issues.

Fire and Fire Suppression

Vernal pool sites that have burned in the last 15 years have shown a wide range of habitat recovery, from full recovery of the ecosystem to complete type-conversion to nonnative habitat. Most fire ecology experts believe the greatest threat to managed resources is an increase in fire frequency, which has been documented in San Diego in the last 10 years. The major threat posed by a high-frequency fire regime is loss of native vegetation. Chaparral, coastal sage scrub, and native grassland vegetation may require two or more decades of fire-free conditions to recover

fully. While vernal pools do not require as much recovery time, vernal pool habitat is directly impacted by problems in adjacent upland watershed resulting from high fire frequency, such as displacement of native vegetation with alien annual grasses and forbs, which can lead to increased flammability, decreased slope stability, and loss of biodiversity (Keeley et al. 2005, 2009).

Following a fire, quantitative data should be carefully evaluated to identify short- and long-term impacts. Impacts from fire-suppression (e.g., vehicle damage, contamination from fire suppressant chemicals) should be addressed promptly.

Trespass

During qualitative assessment, any signs of trespass by pedestrians, bicycles, OHV activity, or equestrian use will be assessed for damage. Unauthorized trails will be closed and signage installed where appropriate. Any damage that alters hydrology will be assessed and measures will be implemented immediately to resolve the problem.

Topographic Disturbance

Qualitative assessment of topographic disturbance will include recommendations for immediate measures, as appropriate. If damage occurs during the wet season, it may be necessary to postpone these measures until the site is dry.

Invasive Species

Qualitative assessment of invasive species is separate from the nonnative cover evaluation performed during quantitative monitoring. The purpose of the qualitative assessment is to identify any serious invasive species issues so it can be addressed immediately. Certain invasive animal species (bullfrogs, gophers, and others), plant species identified as High on the California Invasive Plant Council Invasive Plant Inventory (Cal-IPC 2007), and other highly invasive exotics that are problematic to vernal pools (e.g., *Agrostis avenacea*) will warrant prompt response.

Inundation

A pool occupied by focal shrimp species must inundate at a depth of 3 cm or more at least once in 3 years having 65 % average rainfall. If this does not occur (i.e., the pool does not pond 3 years in a row with adequate rainfall), the complex will be elevated to Monitoring and Management Level 2.

3.3 QUANTITATIVE THREAT TRIGGERS

Based on quantitative data collected for each applicable complex (see Section 2.2.2), the required management level can be determined based on threat triggers. All sites will be evaluated annually for the triggers described below to determine if a complex level should be elevated or lowered. Figure 1-1 displays how the triggers are used to determine the appropriate monitoring and management level.

3.3.1 Level 1 Triggers

Monitoring and Management Level 1 (Chapter 4) is considered the minimum requirement; thus, there is no specific trigger for this level.

3.3.2 Level 2 Triggers

The assessments results from Monitoring Level 1 or Level 3 will determine if a complex should be elevated or reduced, respectively, to Monitoring and Management Level 2. Any of the following conditions will trigger Monitoring and Management Level 2.

Level 2 Triggers for Focal Plant Species

For pools within complexes under Monitoring Level 1 (10% of pools at each complex with focal plant species, or at least one pool where a focal species occurs in less than 10 pools), the following will trigger Monitoring and Management Level 2:

- an average decline of one cover class (see Section 2.2.2) for any focal plant species present in the pools assessed over three years with adequate rainfall, OR
- an average increase of one cover class in combined nonnative cover in the vernal pools over three years, regardless of rainfall. This trigger only applies to complexes with at least 10% total nonnative cover.

Level 2 Triggers for Focal Shrimp Species

For pools within complexes under Monitoring Level 1 (10 pools or 5% of pools at each complex with focal shrimp species, whichever is greater), the following will trigger Monitoring and Management Level 2:

-
- a 20% decline in species density in the focal shrimp species present in the pools assessed over 3 years.

Sites can move from Level 2 back down to Level 1 if conditions improve. The following conditions will trigger a move from Level 2 to Level 1 Monitoring and Management.

Triggers to Move to Level 1 for Focal Plant Species

For pools within complexes under Monitoring Level 2 (all pools with focal plant species), the following will trigger a move to Level 1:

- an average increase of one cover class for ALL focal plant species present in the pools assessed over three years with adequate rainfall, AND
- an average decrease of one cover class in combined nonnative cover in the vernal pools over three years, regardless of rainfall.

Triggers to Move to Level 1 for Focal Shrimp Species

For pools within complexes under Monitoring Level 2 (10 pools or 10% of pools at each complex with focal shrimp species, whichever is greater), the following will trigger a move to Level 1:

- a 20% increase in species density in the focal shrimp species present in the pools assessed over 3 years.

3.3.3 Level 3 Triggers

The assessment results from Monitoring Level 1 or 2 will determine if a complex should be elevated to Monitoring and Management Level 3. Any of the following conditions will trigger Monitoring and Management Level 3.

Level 3 Triggers for Focal Plant Species

For pools within complexes under Monitoring Level 1 (10% of pools with focal shrimp species, or at least one pool where a focal species occurs in less than 10 pools) or 2 (all pools with focal plant species), the following will trigger Monitoring and Management Level 3:

-
- an average decline of two cover classes for any focal plant species present in the pools assessed over three years with adequate rainfall, OR
 - an average increase of two cover classes in combined nonnative cover in the vernal pools over three years, regardless of rainfall. This trigger only applies to complexes with at least 10% total nonnative cover.

Level 3 Triggers for Focal Shrimp Species

For pools within complexes under Monitoring Level 1 (10 pools or 5% of pools at each complex with focal shrimp species, whichever is greater) or Level 2 (10 pools or 10% of pools at each complex with focal shrimp species, whichever is greater), the following will trigger Monitoring and Management Level 3:

- a 40% decline in species density in the focal shrimp species present in the pools assessed over 3 years.
- Additionally, if a complex has remained at Level 2 for 3 years with at least 65% of average rainfall, the complex would be elevated to Level 3 Monitoring and Management.

Complexes at Management Level 3 will be monitored at Level 3 for 1 year after completion of Level 3 management activities. At the completion of monitoring, a complex can move up a level if it meets the criteria. The following conditions will trigger a lower level of monitoring and management.

Triggers to Move to Level 2 for Focal Plant Species

For pools within complexes under Monitoring Level 3 (all pools with focal plant species), the following will trigger a move to Level 2:

- an average increase of one cover class for ALL focal plant species present in the pools assessed over three years with adequate rainfall, AND
- an average decrease of one cover class in combined nonnative cover in the vernal pools over three years, regardless of rainfall.

Triggers to Move to Level 2 for Focal Shrimp Species

For pools within complexes under Monitoring Level 3 (10 pools or 10% of pools with focal shrimp species, whichever is greater), the following will trigger a move to Level 2:

- a 20% increase in species density in the focal shrimp species present in the pools assessed over 3 years.

Triggers to Move to Level 1 for Focal Plant Species

For pools within complexes under Monitoring Level 3 (all pools with focal plant species), the following will trigger a move to Level 1:

- an average increase of two cover classes for ALL focal plant species present in the pools assessed over three years with adequate rainfall, AND
- an average decrease of one cover class in combined nonnative cover in the vernal pools over three years, regardless of rainfall.

Triggers to Move to Level 1 for Focal Shrimp Species

For pools within complexes under Monitoring Level 3 (10 pools or 20% of pools with focal shrimp species, whichever is greater), the following will trigger a move to Level 1:

- a 40% increase in species density in the focal shrimp species present in the pools assessed over 3 years.

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CHAPTER 4

TIERED MANAGEMENT APPROACH

4.1 MANAGEMENT GOALS AND OBJECTIVES

The VPMMP includes three levels for the conservation and preservation of the focal vernal pool plant and animal species, with an optional fourth goal. The conservation and preservation goals for any given complex depend on the condition of the vernal pool habitat and the status of the focal species populations within that complex. The three conservation and preservation goals, and one optional goal, for the VPMMP are as follows:

- The goal of Level 1 Management is to *maintain* existing habitat conditions and existing focal species population status.
- The goal of Level 2 Management is to *stabilize* habitat conditions and focal species populations.
- The goal of Level 3 Management is to *remediate* habitat conditions and focal species populations to baseline conditions defined by the City's Vernal Pool Inventory (2004).
- A fourth goal is to *expand* habitat conditions and focal species populations, where appropriate. This goal is not part of the required management actions for the HCP Preserve, and will require grants and other types of alternative funding sources for implementation.

4.2 MANAGEMENT BACKGROUND AND RATIONALE FOR SUCCESS

Management of vernal pool habitats in Southern California dates back more than 20 years and has ranged from simple site protection to fully developed vernal pool habitat restoration and enhancement. Some of the earliest City sites to be actively managed with habitat restoration and enhancement were Del Mar Mesa (H1-15), Lopez Ridge (B5-8), and General Dynamics (N8). While some conservation progress was achieved, these early projects did not maintain, stabilize, or remediate the vernal pool habitat and the focal species populations. Until the mid-1990s, vernal pool habitat restoration was considered to be an uncertain method of conservation and preservation for the focal vernal pool species.

Beginning in the mid-1990s, multiple vernal pool management programs were implemented on existing or future City lands. These programs were more aggressive in the scope and level of

effort than previous restoration programs. The goal of such programs was to stabilize, remediate, and expand vernal pool habitat and the focal species populations. Projects were implemented on a number of sites throughout the City, including Greystone Torrey Highlands (H39), Robinhood Ridge (J4), West Otay A, B, and C (J32), and Cal Terraces (J2S and J2N). Most recently, a *TransNet*-funded restoration program was implemented at Otay Lakes (K5), Marron Valley (MM1), Nobel Drive (X5), and Goat Mesa (J16-18) to address focal species population decline or extirpation noted during MSCP monitoring. This program was successful at stabilizing and reestablishing focal species populations during the 3-year timeframe. However, these sites need continued maintenance for focal species populations to remain stable.

Based on the known successes in Southern California of vernal pool habitat restoration efforts, there is strong evidence that habitat restoration and enhancement can achieve the VPMMP goals discussed above in Section 4.1.

4.3 MANAGEMENT LEVELS

As discussed above, Monitoring Level 1 and Management Level 1 are considered the minimum requirement unless baseline conditions warrant a higher level (see Chapter 3). Monitoring Level 1 will determine if higher level triggers have been met, at which point a complex will be elevated to a higher management level. Likewise, Monitoring Level 2 and Level 3 will determine if a complex should be moved to a higher or lower management level. Figure 1-1 illustrates this concept. Monitoring levels are discussed in Chapter 2 and management levels are discussed below.

Because of seasonal climate variability and resulting effects on the expression of both invasive species (weed germination, flowering, and seed-set; dispersal of invasive animals, etc.) and focal species (plant germination, flowering, and seed-set; shrimp hatching, development, and reproduction, etc.), the activities described below will be applied for a minimum of two years. If, after two years of implementation of Management Level 1 or Level 2, the complex is still triggering the same management level, then the respective management level will continue until the complex meets the respective trigger thresholds.

Selected management activities within a particular management level will be implemented at a particular complex based on site needs (Attachment A). Management levels were assigned to each complex based on a review of existing available quantitative and qualitative data to determine site status and the management needs. Limited quantitative data has been collected on complexes within the Preserve since the baseline data was collected in 2002-3. Quantitative data is only available for a small subset of the complexes and focal species basins. For the majority of

the complexes, only qualitative information was available for the initial management level assessment. Qualitative information and input was provided by senior biologists and local experts from SANDAG, USFWS, the City, and AECOM, whom are most familiar with vernal pool habitat and management in San Diego. These experts have observed qualitative changes in focal species populations, general vernal pool habitat quality, and other site conditions over the last ten years. The local vernal pool experts used available qualitative data to collaboratively determine the appropriate management level when quantitative data was unavailable or incomplete. In general, quantitative and qualitative data was evaluated and, to the extent feasible, compared to the management level triggers described in Sections 3.2 and 3.3.

4.3.1 Management Level 1

The goal of Level 1 Management is to *maintain* existing habitat conditions and existing focal species population status.

Management Level 1 is the minimum requirement for all vernal pool complexes within the Preserve subject to the City's jurisdiction. The need to conduct these management activities will be assessed through qualitative and quantitative monitoring. General management activities that will be required for every complex annually are described below.

Trash and Debris Removal

All complexes will be kept free of trash and debris through annual or as-needed removal.

Fencing and Signage Maintenance

Every complex will be protected with site-appropriate fencing, vehicle barriers, and/or other access controls. Any complex without adequate protection will be fenced or protected by other types of access barriers.

Status of access restrictions will be documented as part of the qualitative monitoring. If problems are identified, recommendations for repair or replacement will be made and implemented (e.g., replacement of locks, gates, or signs; or fence repairs).

Edge Effects Maintenance

Recommendations for addressing edge effects that are noted during qualitative monitoring will be implemented. This may include changes in irrigation designs or schedules, modification of

landscape species, erosion-control measures, dust-suppression measures, and other adaptive efforts.

Fire and Fire Suppression Damage Repair

If a complex is affected by fire, there are general expectations for recovery and for invasion by weeds (see Section 3.2). Any damage that is a result of fire suppression (fencing damage, vehicle damage, contamination from fire suppressant chemicals, etc.) will be addressed immediately.

Trespass Damage Repair

During qualitative assessment, any signs of trespass by pedestrians, bicycles, ORVs, or equestrian use will be assessed for damage. Unauthorized trails will be closed and signage installed, where appropriate. Damage that alters hydrology will be assessed and measures will be implemented to resolve the problem.

Topographic Disturbance Repair

The qualitative assessment of topographic disturbance will evaluate the following:

- Pool integrity and hydrologic function
- Shape and size of disturbance and overall pool
- Depth and duration of ponding
- Need for hand work or mechanical equipment for repairs
- Need for watershed analysis and/or microtopographic plans

A complex with minor or no topographic damage will be assigned Level 1. Moderate topographic disturbance that affects pool integrity, ponding potential (depth and duration), or overall size will be assigned for Level 2 microtopographic repair, which involves mechanized equipment and hand work. A complex with more extensive topographic disturbance that requires mechanized equipment use, and potentially a microtopographic plan, will be assigned for Level 3.

Qualitative assessment of topographic disturbance will include recommendations for remedial measures, as appropriate. If damage occurs during the wet season, it may be necessary to postpone topographic repair until the site is dry.

Targeted Invasive Species Control

This activity is separate from the general nonnative species control activities that are required for Management Level 2 and Level 3 (see below). This activity is specific to any target invasive problems (plant or animal) that are identified during qualitative monitoring that do not require and/or cannot wait for Management Level 2 or Level 3 nonnative control activities to be implemented (see Section 3.2).

4.3.2 Management Level 2

The goal of Management Level 2 is to *stabilize* the existing habitat conditions and focal species population status.

Management Level 2 includes all activities listed for Management Level 1, plus the additional activities discussed below. The specific methods are described in Section 4.4.

Dethatching

Dethatching is recommended prior to other types of weed control. Although some complexes may require weed control without dethatching, this will be evaluated on a complex-by-complex basis. For example, dethatching is not needed to treat invasive forbs at a complex with limited thatch.

Weed Control

Weed control includes all aspects of invasive plant control such as hand weeding, mechanical weeding, and herbicide use. For Management Level 2, Weed Control-2 (two full visits per spring) will be conducted on the vernal pools with focal species plus a 20-foot watershed buffer. A 20-foot buffer around a pool is approximately equivalent to a 5:1 watershed-to-vernal pool area ratio (based on the average size of vernal pools in the HCP Preserve that have focal species). Management of the upland watershed habitat at this ratio is considered appropriate when the site needs stabilization of habitat and focal species populations.

Seed Collection/Bulking/Dispersal

Seed Collection/Bulking/Dispersal-2 (one greenhouse generation) will be implemented for declining focal plant species to reestablish focal species seed banks following weed control. All pools with declining focal plant species will be included in this program. While it is possible to

grow more than one generation in the greenhouse in a year, it is most effective to time greenhouse planting so some container plants can be used for planting (if required) and some can be used for seed production. With this approach, only one generation of plants can be propagated in any given year. At Management Level 2, the seed bank is assumed to still be intact, but in need of rejuvenation, so a single seed bulking event is appropriate.

Cyst Collection/Bulking/Inoculation

If quantitative monitoring indicates loss of one or both focal fairy shrimp species, shrimp cyst soil will be collected for bulking. Under Management Level 2, one generation of Cyst Collection/Bulking/Inoculation-2 will be conducted. All pools with declining focal shrimp species (as determined by the triggers outlined in Section 3.3) will be included in the program.

A cyst bank bulking inoculation program is experimental in design and implementation, and should only be conducted under the direct supervision of a qualified biologist with permits for handling endangered fairy shrimp species. The guidelines discussed below should be considered.

Cyst-rich soil will be collected prior to grading for construction. Soil will be taken to a lab, placed in artificial basins (plastic pools or tubes), and then inundated for at least 4 weeks to hatch the fairy shrimp and other crustacean species. A reverse osmosis system would be used to remove minerals and chemicals (chlorine) from the water.

Fairy shrimp and other crustacean species that develop into adults will be identified, removed from the plastic inoculation pools, and placed in smaller containers for egg and cyst collection. These small cyst collection containers will have a sterile soil medium (clean sand) to catch developed eggs and cysts that are released by mature fairy shrimp and other crustacean species. The adult male San Diego fairy shrimp and male Lindahl's fairy shrimp are difficult to distinguish without the use of magnification, which usually requires the shrimp to be killed before identification. However, the females of these two species can be identified accurately without magnification. To ensure that the San Diego fairy shrimp is the only shrimp species being inoculated, only adult females that have bred and developed cyst sacs will be placed in the collection containers.

San Diego fairy shrimp and other crustacean species that are transferred to collection containers will drop their eggs and cysts into the sterile medium. Once the adult crustacean species reproduced and completed their life cycle, the collection containers will be dried so that the sand rich with eggs and cysts can be collected and stored. This method will greatly reduce the chance of inoculation with Lindahl's fairy shrimp.

Topographic Reconstruction

Where necessary, ponding characteristics, flow patterns, and other hydrological functions will be reestablished using hand tools and/or equipment, as appropriate. This program may require a more detailed plan for grading if equipment is used.

4.3.3 Management Level 3

The goal of Management Level 3 is to *remediate* the habitat conditions and focal species population status to baseline conditions (defined by the 2004 City Vernal Pool Inventory).

Management Level 3 includes all activities listed for Management Level 1, plus the additional activities discussed below. The specific methods are described in Section 4.4.

Dethatching

Refer to Section 4.3.2 for a discussion of implementing dethatching.

Weed Control

For Management Level 3, Weed Control-3 (four full visits per spring) will be conducted on the vernal pools with focal species plus a 35-foot watershed buffer. A 35-foot buffer around a pool is approximately equivalent to a 10:1 watershed-to-vernal pool area ratio (based on the average size of vernal pools in the HCP Preserve that have focal species). Management of the upland watershed habitat at this ratio is considered appropriate when the site needs remediation of habitat and focal species populations.

Seed Collection/Bulking/Dispersal

Seed Collection/Bulking/Dispersal-3 will involve two greenhouse generations. Seed collection from off-site sources may be considered if the potential seed bank on-site is either gone or too limited to collect from.

At Management Level 3, the seed bank is assumed limited and in need of remediation, so two seed bulking events are appropriate.

Cyst Collection/Bulking/Inoculation

Cyst Collection/Bulking/Inoculation-3 will involve two generations. All of the pools with the declining focal shrimp species will be included in the program. Other than being conducted for two generations, the cyst bulking program will follow the direction provided under Management Level 2. Cyst collection from off-site sources may be considered if the potential cyst bank on-site is either gone or too limited to collect from.

Container Plant Production/Installation

Under Management Level 3, container plant production will be conducted for the annual focal plant if timing is appropriate (see Section 4.4.4). One container plant installation event will occur for Management Level 3, ideally in the first year of management.

Topographic Reconstruction

Refer to Section 4.3.2 for a description of topographic reconstruction.

4.4 MANAGEMENT METHODS

The sections below describe the methods for the management activities at each management level.

4.4.1 Fencing and Signage

The majority of vernal pool complexes are currently fenced; however, additional fencing will be installed when necessary to properly protect the complex. The type and length of fencing at each complex will depend on site needs, which will be assessed during the qualitative site visit. Typical fence types are as follows:

- three-stranded barbless wire
- two-plank woodcrete
- ORV deterrent fencing
- 6-foot-high chain-link

Fence installation will occur outside of the avian breeding season so that installation does not disturb nesting birds or other wildlife. To the extent feasible, existing access roads will be used to minimize disturbance to habitat.

4.4.2 Weed Control

The weed control program will include dethatching as necessary, followed by herbicide and other weed control measures.

Dethatching is most appropriately performed in the winter, prior to the avian breeding season, with follow-up visits during the spring and early summer. Spring and summer herbicide application and other weed control measures (e.g., use of weed-eating equipment) will be based on rainfall patterns and the germination and development of the nonnative target species at each complex, not on a predetermined schedule.

Dethatching

Within vernal pools and surrounding watersheds, sensitive biological resources are suppressed due to thatch accumulation. The primary purpose of dethatching is to remove nonnative biomass, exposing more soil within the vernal pool basins or upland watersheds to improve the germination of native species and reduce competition.

Dethatching is usually most effective while nonnative seed heads are still on the stalks, when seed can be effectively removed along with the thatch. Removed thatch will be transported off-site and disposed of at an appropriate facility.

Dethatching makes future weed control measures more effective and efficient by exposing germinating weed species for herbicide application.

Collection of target native plant seed should occur prior to dethatching to minimize the removal of the native seed bank. Seed can be stored until the next growing season or put back on-site following completion of dethatching and cleanup.

Hand Weeding

Hand weeding is inefficient and relatively expensive, but it can minimize inadvertent impacts to focal species, the watershed, and wildlife. However, trampling and soil disturbance may occur, countering the effects of weeding. Hand weeding should only be used in vernal pools or in the

upland watersheds when it can be accomplished efficiently or where other methods cannot be applied.

Weed Eating and Mowing

Weed eating and mowing can be effective tools to prevent nonnative species from flowering and reproducing. Weed eating is appropriate in both the vernal pools and their surrounding watersheds, while mowing is appropriate only in the surrounding upland watersheds. A combination of weed eating and mowing can be effective and efficient if done by trained crews, especially when sensitive native plants are surrounded by larger areas of weed-dominated cover. A “high” mow should be used (i.e., no shorter than 6 to 8 inches) to prevent native species from being destroyed or damaged, and to minimize risk to ground-foraging wildlife. In general, weed eating and mowing are not a significant threat to invertebrate wildlife, as long as soil is not disturbed.

In general, regular weed eating or mowing treatments should begin in later winter and early spring, when nonnative species are tall enough for these methods to be effective but have not yet flowered. In years with late rainfall, this timing can be pushed back to late spring. Cut material should be removed using mowing bags or hand cleanup.

Herbicide Use

Herbicide is often most effective method of weed control in native habitats but can be costly. Herbicide should be appropriate for use around aquatic invertebrates to limit impacts to ponded vernal pools. Misuse of herbicides can cause substantial damage to native plant species, habitats, and wildlife, especially in aquatic environments. Herbicide will only be used in the upland watershed and at least 3 feet from vernal pool habitat at all times.

Herbicide use is most effective in the earlier stages of plant germination and establishment. It is easier for herbicide applicators to avoid spraying native species early in the season, as the native and nonnative species have more spatial separation early in the growth cycles. This is especially true if the herbicide treatment area has been dethatched prior to fall/winter germination.

Application of glyphosate-based herbicides such as RoundUp or Aquamaster will be applied to targeted areas. Herbicide will only be applied when wind speed is less than 5 miles per hour and with spray nozzles designed to maximize the size of droplets to reduce potential drift. Where feasible, a 10-foot buffer will be maintained around concentrations of any sensitive plant species. Application of herbicide will not occur if rain is projected within 24 hours.

Herbicide may be sprayed or applied by hand with various specialized applicators. An herbicide wick-staff can be used to directly contact plants by hand to eliminate risk of overspray.

4.4.3 Seed Collection, Bulking, and Dispersal

When introduction of sensitive species is needed, a seed collection and bulking program may be used when the focal plant species are not commercially available.

Seed will be collected in the fall, and taken to a seed bulking facility (e.g., S&S Seeds) so that seed is ready for site broadcast by the spring of the following year. No more than 10% of any given population from a given pools will be collected.

4.4.4 Container Plant Production and Installation

As discussed above for Management Level 3, container plant production and installation will be considered for declining focal plant species. Plants that are being grown in the greenhouse for seed bulking purposes will be considered for planting, but only if site conditions and seasonal rainfall are adequate.

If container plants are early in development and the timing is such that vernal pools have filled with water in the winter or early spring, a portion of these greenhouse plants will be brought to the complex and installed into the pools where the seed was originally collected. This installation of greenhouse container plants will only be conducted under these conditions and only if more rainfall is expected. It is difficult to take care of vernal pool container planting if the pools are not ponded and the soil is not saturated.

Plants will be carefully installed within the ponded basin area, working from the pool margins to reduce impacts to the pool basin. Only the annual focal plant species will be considered for container plant installation, so San Diego button-celery will not be targeted for a container planting program.

4.4.5 Topographic Reconstruction

Recontouring will involve the reshaping of mima mounds and excavation of basin areas to mimic natural vernal pool/mima mound topography for areas that have clear mound and basin topography (either currently or based on historical photographs). Recontouring may include all or some of the following methods:

-
- excavation/creation of new basins and contouring of new mounds using a small bulldozer in historical mima mound fields,
 - decompaction and recontouring of vernal pools in dirt trails using a small bulldozer or hand tools where equipment is not allowed, and/or
 - recontouring to remove vehicle tracks and other disturbances using a small bulldozer or hand tools where equipment is not allowed.

If grading or excavation is required for recontouring, a grading plan may be necessary. Grading would be performed during the dry season with a bulldozer that is small enough to access and maneuver within the site. The limit of work will be grading as indicated on the grading plan. Mima mounds that function biologically and appropriately, and that contain sensitive biological resources, will be left intact. Vernal pools will be slightly overgraded (1 to 2 inches) and backfilled with topsoil to promote plant propagation.

A final pregrading field visit will be conducted to delineate areas of cut and fill using a trail of flour and/or pin flagging. No spray paint will be used. A complete set of preconstruction photographs will be taken at this time. The grading operator will be familiarized with the complex and issues involved during a preconstruction site visit.

Areas to be manipulated with grading equipment or hand tools will be graded before the saturation of soils. Site grading and construction of mima mounds will be performed by using no less than one-third of the cut soil as fill material for mima mounds (0.3:1), and fill will be balanced to avoid off-site export of usable soil when possible. Work will be monitored with a laser transit to ensure that the design is followed and that the depths and flow patterns are correctly maintained or modified.

4.4.6 Restoration and Management Plan

For certain complexes, a detailed Restoration and Management Plan (RMP) may be necessary to direct implementation of management activities. The need for a RMP will be determined based on the complex management recommendations and/or current regulatory requirements that apply to a specific complex.

A RPM will discuss the goals and objectives of habitat management and identify specific requirements to maintain, stabilize, and or remediate the focal species that are known from a particular complex consistent with the VPMP. A RPM may include the following information and implementation guidance:

-
- Fencing and signage installation or repair requirements, including any additional access related issues
 - Directives, methods and scheduling for dethatching, hand weeding, mowing (including line trimming), and herbicide use (methods and limitations)
 - Specifications for seed collection, seed bulking, and seed dispersal, including methods and limitations
 - Specifications for container plant production and installation, including methods for growing and planting, methods for plant care, and limitations
 - Directives for evaluating, planning, and implementing topographic reconstruction, potentially including detailed microtopographic mapping and design

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CHAPTER 5

DESIRED ACTIONS

The goal of the VPMMP is to maintain, stabilize, and remediate the seven focal species populations through implementation of necessary management actions identified for each complex in Attachment A. This chapter recommends potential additional actions (in addition to those included in attachment A) that may expand the focal species populations at individual complexes or provide valuable information on associated ecological factors. These desired actions are not required for implementation as part of the vernal pool HCP but could be implemented separately if and when additional funding and resources become available. Desired actions are categorized into three topics: research, data collection and analysis, and restoration of historical vernal pool habitat.

5.1 RESEARCH

Options for research efforts to better understand focal species population dynamics include the following:

- Develop and test a methodology to better estimate population density or population size for fairy shrimp. This study would help to resolve the current lack of quality data collected from USFWS protocols for fairy shrimp population estimates.
- Conduct studies to determine the extent of hybridization with versatile fairy shrimp and its effects on San Diego fairy shrimp reproduction, population genetics, and viability.
- Conduct genetic studies for fairy shrimp to better understand population genetics and the relationships between and among vernal pool complexes.
- Research the relationship between focal plant and fairy shrimp presence and/or densities to better understand which species, or assemblage of species, are the best for use in habitat-quality evaluation benchmarks.
- Research which pollinators are important to each of the focal species, where these pollinators occur, and how these species can be targeted in habitat restoration and management.

5.2 DATA COLLECTION AND ANALYSIS

Options for data collection and analysis efforts to better understand focal species population dynamics include the following:

- Perform vernal pool monitoring using the California Rapid Assessment Method (CRAM) Vernal Pool Module. CRAM is a state-wide program that looks at various wetland types across California, and it is important to incorporate the City's vernal pool data into the state-wide CRAM database.
- Perform vernal pool monitoring using the Hydrogeomorphic Approach (HGM). While the data collection methods for the focal plant species can be used in the HGM evaluation, the focal shrimp species data collection methods are not adequate for this model. Collection of HGM-level crustacean data will provide key information for use in an HGM model, providing another method for habitat evaluation and adding to the HGM model database.
- Perform long-term trend analysis on vernal pool complex monitoring data to develop individualized monitoring and management triggers for each complex to allow complex differences that are not being evaluated with the current proposed methods.

5.3 RESTORATION OF HISTORICAL VERNAL POOLS AND FOCAL SPECIES POPULATIONS

5.3.1 Restoration of Historic Vernal Pools

This desired action would involve review of historical records and aerial photography to determine historic locations of vernal pools within preserved complexes. Vernal pools would be restored to mimic historic site conditions and placed where historic pools were known to exist (not where pools currently exist). This would require development of a detailed restoration plan to be approved by USFWS, as well as obtaining necessary City permits and approvals. Depending on site conditions, restoration activities would be similar to those described under Management Level 3, except more specific emphasis would be placed on the expansion of existing focal species populations into historical habitat through restoration and creation.

5.3.2 Restoration of Historic Focal Species Populations

This desired action would involve reestablishing historic focal species populations that have been (or are thought to be) extirpated from a complex. Historical data (i.e., previous to the 2004 baseline data established for the HCP) and available documentation would be reviewed to identify specific pools in a complex with historical focal species populations that are thought to be extirpated. Reestablishment of focal species in a pool would involve a program of seed collection and bulking, and container plant propagation and installation, similar to the activities described under Management Level 3.

Table 5-1 lists the complexes that should be considered for reestablishment of focal species populations.

Table 5-1
Vernal Pool Complexes to Consider for Focal Species Population Reestablishment

Complex ID	Name	Species for Reestablishment
J 11 E	Slump Block Pools	ORCA
J 11 W	J 11 West	STWO
J 12	J 12	ORCA, ERAR
J 13 E	J 13 East	ORCA
J 14	905, Anderprises, Bachman, Brown Field Basins,	NAFO, ERAR, PONU

ERAR = San Diego button-celery; NAFO = Spreading navarretia; ORCA = California Orcutt grass; PONU = Otay Mesa mint; STWO = Riverside fairy shrimp

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CHAPTER 6

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ATTACHMENT A
VERNAL POOL COMPLEX EVALUATION AND
MANAGEMENT RECOMMENDATIONS

To Be Provided

ATTACHMENT B
VERNAL POOL COMPLEX
MONITORING FORM

City of San Diego Vernal Pool Habitat Conservation Plan Monitoring Form

<i>Monitor Name & Affiliation:</i>	<i>Date:</i>
<i>Complex ID:</i>	<i>Complex Name:</i>
<i>Pool ID:</i>	<i>Date:</i>
<i>Land Owner/Manager:</i>	

I. QUALITATIVE MONITORING

Mark all boxes that apply

<input type="checkbox"/> Fencing & Signage Disturbance	<input type="checkbox"/> Bicycle or Equestrian Use	<input type="checkbox"/> Topographic Disturbance
<input type="checkbox"/> Trampling (human or cattle)	<input type="checkbox"/> Erosion	<input type="checkbox"/> Altered Hydrology
<input type="checkbox"/> Off-Road Vehicle Use	<input type="checkbox"/> Fire	<input type="checkbox"/> Invasive Species
<input type="checkbox"/> Other _____		

Notes: (describe impact in more detail including % of pool and/or complex affected)

Habitat Condition (see back for description)

☐ Very Good - Excellent
 ☒ Fair to Good
 ☐ Poor
 ☒ Very Poor

Pool Inundation

II. MANAGEMENT RECOMMENDATIONS

III. QUANTITATIVE MONITORING

Monitoring Level ☐ Level 1 ☐ Level 2 ☐ Level 3

Flora Speices Observations
(check cover class for each species, add additional native and nonnative species as necessary)

Species	<1%	1-	5-10%	10-25%	25-50%	50-75%	75-100%	Species	<1%	1-5%	5-10%	10-25%	25-50%	50-75%	75-100%
PONU															
POAB															
NAFO															
ERAR															
ORCA															

Fauna Species Observations

	Observed in Pool	Collected	# Males Collected	Est. Poptation (1's, 10's, 100's, 1,000's)
<i>Brachinecta sp.</i>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____
<i>Streptocephalus woottoni</i>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____

IV. OBSERVATION AREA/MANAGEMENT UNIT LOCATION

Accuracy of Coordinates/GPS Error: +/- _____ ☐ meters ☐ feet

Observation Location: _____ ☐ State Plane (feet) ☐ UTM

V. SITE PHOTOMONITORING

Location [State Plane (ft)]	Direction (facing)	Height	Camera Angle	Photo #	File location/s
Location [State Plane (ft)]	Direction (facing)	Height	Camera Angle	Photo #	File location/s
Location [State Plane (ft)]	Direction (facing)	Height	Camera Angle	Photo #	File location/s

VI. OTHER NOTES/COMMENTS

Modified Trudgen & Keighery Vegetation Condition Scale

Very Good-Excellent	80-100% Native Flora Composition Vegetation Structure intact or nearly so Cover /abundance of weeds < 5% No or minimal signs of disturbance
Fair to Good	50-80% Native Flora Composition Vegetation structure modified or somewhat modified Cover/abundance of weeds 5-20% any number of individuals Possible minor signs of disturbance
Poor	20-50% Native Flora Composition Vegetation structure modified Cover/abundance of weeds 20-60% any number of individuals Disturbance incidence high
Very Poor	0-20% Native Flora Composition Vegetation Structure disappeared Cover/abundance of weeds 60-80% any number of individuals Disturbance incidence very high

**Review of Technical White Papers 3 & 4:
Adaptive Management and Monitoring Strategy for the City of San Diego
Vernal Pool Habitat Conservation Plan**

Draft version “2011-60218732 Technical White Paper 3 & 4_Revised” of January 12, 2012

Dr. Andrew J. Bohonak

Professor of Biology, San Diego State University

submitted 19 March 2012

Summary

Reviewing Technical White Papers 3 and 4 is challenging in many respects. First, this document seems to be designed to stand alone, even though there is overlap in content and motivation with those TWPs that precede and postdate it. Second, the eventual intent (as I understand it) is for these TWPs to be merged into a single draft HCP. Although the HCP will benefit from extensive and varied reviews of the contributing papers, it is difficult at this time to envision what that final product may look like. Thus, some of my requests for additional information may be irrelevant if that information appears elsewhere in the TWPs.

A second challenge is understanding where the final document will lie on the gradient between a purely mechanical management guide, and a well-referenced and researched treatise on the long-term viability of San Diego County’s vernal pools. I had many questions about the justifications for specific numerical targets and triggers throughout TWPs 3 and 4. If those justifications and assumptions are not described in detail and justified in the final HCP, then I would recommend that a separate supporting document with that information be required. Adaptive management should be based on the best available scientific information and current field data, and be open to objective external and internal reviews. Objective review will require that the scientific assumptions underlying the management plan be described and referenced whenever possible.

Thus, my comments are organized into two categories:

- 1) Those revisions that would improve the document in terms of clarity, utility for monitors and managers, and the potential for actual implementation.
- 2) Additional questions about the justification for specific methods and “triggers” in the monitoring and management plan.

Clarity, utility and potential for implementation

1. TWPs 3 and 4 are generally well written, and I noticed few if any editorial mistakes. However, this white paper fails as a stand-alone document covering management and monitoring in vernal pools. There are many places where I had questions about the context in which specific terms were being used, or the justification for specific details. Additional

cross-referencing between this document and the other TWPs would help tremendously, particularly in the first 8 pages of TWP 3/4. Hopefully the final HCP will improve in this regard.

2. Who specifically will review and oversee monitoring, management and remediation? A single person? The City? SANDAG? USFWS? A panel of some sort? How often would this panel be charged with meeting and reviewing progress? How often would a complete review of the "state of the resources" be required?
3. Similarly, after a "trigger" is detected, what is the time frame within which an action must be taken? What agency is responsible for implementing that action? Will funding be set aside for implementing these actions as necessary?
4. Section 1.4: The distinction between *maintain* (Level 1) and *stabilize* (Level 2) was not apparent to me, unless these terms are being used in a technical sense that was defined elsewhere. To me, those two terms are synonymous. Similarly *status* needs to be defined here, or cross-reference to other parts of the document.

These three levels are described as "goals" but that is confusing. They are not goals; they are population states. "Tier" is used to mean "level" in one sentence.

After reading this document many times, I am fairly sure that I understand what is going on, but it took several readings. The language in the first 4 paragraphs of 1.4 should be revised for clarity.

5. Additional minor comments
 - i. 1.3: see comments below about justification for quantitative triggers. Also, the language in b) at the bottom of page 3 is quite confusing.
 - ii. Table 2-2: "Number of pools". Is that the number of pools at the time the survey is conducted? The number present at time 0 (when the HCP takes effect)? Maximum number that were ever present in that complex?
 - iii. Figure 1-1 seems unnecessary.
 - iv. 2.2.1: Trespass. I think that the definition should be broadened to estimate usage/visitation of the surrounding landscape. Not all sites are completely fenced off.
 - v. 4.3.1 implies that all vernal pools in the HCP/MSCP will be completely fenced off from public access. Is that correct?
 - vi. The overlap in content between 3.2, 4.3, 4.4 is a bit confusing.
 - vii. Bulleted points in section 5.1: see comments below.

Scientific justification for methodology

6. No mention of already developed monitoring methods is made until section 5.2. There isn't any justification for ignoring the methods that have been developed for CRAM and/or HGM. The Bauder et al. HGM guidebook isn't even referenced. For each of the vernal pool functions that are reviewed in that guidebook, both direct and indirect (rapid) measures of function are provided. The methods in that guidebook were all calibrated to local vernal pools in San Diego County, and I'm not sure why that information is being ignored. In

addition to the numerical models (i.e., estimates of function on a scale of 0 to 1), we developed a more specific way to categorize plants than the native/non-native designation provided here.

7. I submitted a report in February 2011 for a USFWS section 6 grant that outlined quantitative methods for fairy shrimp dry season surveys. It also included some preliminary experiments to test the accuracy of various wet season fairy shrimp sampling methods. That information should be used to inform the fairy shrimp monitoring protocol used in the HCP. DFG and USFWS have this report, and I can provide a copy on request.
8. Why is there no wet-season fairy shrimp monitoring, either qualitative or quantitative? Considering the amount of time and expertise that will be needed for the plant species monitoring, this seems to be an anomaly.
9. More broadly, this monitoring program is very plant-centric. Why is little or no effort made to monitor other functions, such as hydrology, or landscape connectivity? We provide rapid methods (indirect metrics) for estimating these functions in the Bauder et al. guidebook that would require little additional effort.
10. Regarding plant monitoring: the use of "cover class" would seem to require more justification. I'm not a botanist, but my sense is that this is not appropriate for some of the vernal pool plants, and that year-to-year consistency probably varies dramatically between plant species. Is the cover class for the entire basin? For the parts of the basin in which a species is localized? What about species that occur in "rings" corresponding to specific microelevation/moisture gradients?

Regarding the Trudgen vegetation condition scale, I imagine that it would be difficult to apply with a high degree of repeatability. Cover varies widely within and between years, dependent on rainfall. Definitions of disturbance are not given.

See the Bauder et al. HGM guidebook for additional floristic details, definitions and examples of disturbance at various levels, and verbal definitions of high vs. low function. See especially appendices C6, D1, D2, D3, D6.

11. As a population biologist, I found myself repeatedly returning to one question: what is the relationship between the goals and objectives of this plan, and a Population Viability Analysis? I would have liked to have seen a verbal definition of a PVA, and a description of how exactly the management plan's goals fit into that conceptual framework. For example, a goal of the VPMMP is to stabilize populations, which is analogous to a PVA's estimation of the probability of extinction. One important aspect of a PVA is a time horizon over which the extinction probability is examined. There is no specific time frame in TWP 3/4, and I didn't notice one in TWP 2 either. Why does this matter? It seems to me that environmental variation, the frequency of monitoring, and the types of threats that need to be accounted for all depend on the time frame over which vernal pool resources are meant to be maintained/stabilized/remediated (Levels 1/2/3). Due to our variable climate, the relevant timeline should be at least 20 years, and perhaps 50 years. And once we acknowledge this longer timeline, concerns about physical disturbance to the pools need to be supplemented with considerations of

- i. climate change (both temperature and precipitation)
- ii. change in groundwater and above-surface flow due to urbanization that may impact some complexes
- iii. projections for increases in recreational activities that impact vernal pools in publicly accessible areas.

Although formally incorporating a quantitative PVA into the HCP (or supplementary support documentation) would be ideal, I realize that it may not be feasible. Still, the existing methods and their justifications could be summarized in the language of conservation biology / PVAs for more transparency in the scientific review process.

For example, section 3.3: what is the implicit assumption between these triggers and population viability? Why does one cover class trigger an action and not two? Why is a 20% decline in fairy shrimp density the trigger? Is that figure of 20% related in some quantitative way to population maintenance (or conversely, likelihood of extinction)?

*** Why is it 20% decline over the previous 3 years, and not 20% decline from the original baseline?

Why is a 3 year decline cited for the fairy shrimp, as opposed to a shorter or longer time period? What if there was little or no ponding for those three years? Was the within-pool variance in shrimp cyst density estimates considered when coming up with this threshold?

Why is density used for both plants and shrimp? Doesn't population persistence depend on the absolute numbers of individuals?

12. Section 3.1. More specific guidelines on the amount of rainfall needed to monitor biological function are provided in the HGM guidebook. Also, 65% \neq two-thirds.

13. Cyst collection/bulking (p. 30).

- i. Shouldn't the language in paragraph 2 also apply to plants of concern?
- ii. Every mention of off-site sources in this section should require USFWS consultation.
- iii. Topographic reconstruction: "reestablished" to what baseline?
- iv. Grading is mentioned in several places, but I don't see any requirement that a qualified temporary wetland hydrologist review plans for major restorations. Considering the amount of money that is spent on extensive restoration projects, shouldn't that be required?

14. Section 5.3 doesn't have many specifics. What is the "historic" date that is implied as a baseline? Does it vary by complex? Is this section only relevant for areas for which old aerial photos can be found?

And how does restoring to some historical baseline fit in with the monitoring plan goals? It seems like a separate issue, since additional pools and complexes may not be necessary to maintain the existing pools in their current state indefinitely.

Questions for Scientific Advisors

Technical White Papers (TWP)

**3 Draft Development of Adaptive Management Strategy
and
4 Draft Development of Monitoring Strategy**

Questions for Scientific Advisors

Draft version "2011-60218732 Technical White Paper 3 & 4_Revised" of January 12, 2012

Dr. Andrew J. Bohonak

Professor of Biology, San Diego State University

submitted 19 March 2012

Answers to the 21 questions below are summarized from the complete review, submitted separately.

1. Are there additional sources of literature/information not in the TWP that should be consulted?

See comments 6-7 in my full report regarding previously developed methods for vernal pool assessment and fairy shrimp dry season surveys.

2. The proposed adaptive management and monitoring plan uses a decline of one cover class of the focal plant species over three years or an increase in one cover class (when complex has at least 10% weeds) of nonnative species over three years to trigger an increased level of management and monitoring. Using the City of San Diego's rare plant monitoring data as pilot data, do these seem like acceptable triggers? See spreadsheet for City Data (Scientific Advisors_City SD VP Rare Plant Data_1-13-12).

See comments 10-11 with questions about the use of cover classes. Also comment 11: It is unclear what the specific rationale for these triggers is. How do these triggers relate quantitatively to the population biology of the focal species, and the management goals?

3. The proposed monitoring methods move away from the HGM and CRAM methodologies and use cover of focal plant species or density of focal shrimp

species and changes in these variables as triggers. Does this seem reasonable with the understanding that the desired outcome of the monitoring is to know when to increase or decrease management actions and not necessarily characterize the pools in the complex? Does HGM or CRAM provide anything critical that the proposed methodology does not?

See comment 6. The question posed above assumes that CRAM and HGM do not contain methods for assessing plant and invertebrate communities. This is an incorrect assumption. The question also implies that HGM methods would take more time and/or be less relevant for pool management than those that are presented. These are also incorrect assumptions. Please read the HGM guidebook (and perhaps CRAM as well). Please provide a specific justification given for not using those methods.

4. The last benchmark for City of San Diego vernal pools was done in 2004. This was a normal rainfall year (10.36 inches). Does this seem like an acceptable baseline? Would you recommend another year for a baseline? Would you recommend monitoring to collect new baseline data for year 1?

The fact that the 2004 city survey will serve as a baseline is mentioned very briefly at the bottom of page 5, and again later in section 4. To be honest, I missed this detail until reading the above question.

See comment 11 regarding specific concerns about how declines will be assayed. See comment 14, which asks how/whether a specific baseline is relevant for the question of population stability. I'd like to know exactly why we need a baseline, as opposed to knowing what conditions are needed to support a fully functional vernal pool. If a pool was in an unsustainable condition in 2004, why should that be the standard for comparison? The HGM approach circumvents the problem of what baseline to use by attempting to establish what criteria define a fully functional vernal pool.

5. The proposed monitoring plan would be based upon qualitative and quantitative monitoring. The qualitative monitoring would document the general site, threats and status for the complex. Is there anything else you would propose to add to this qualitative monitoring? Is there anything that can be added to enhance comparison across years and across complexes?

The HGM guidebook contains four indirect monitoring methods that are quantitative, but would take very little time to implement in the field. This provides an intermediate level of monitoring between simply noting that the site has been trespassed, and doing complete vegetation surveys.

6. The quantitative monitoring looks at the following indices: cover class of rare plants, presence of fairy shrimp and cover class of weeds. Are these appropriate indices for monitoring? Are there additional indices that should be considered?

See comments above and in the full report about HGM.

7. Since presence/absence surveys of shrimp are difficult to schedule, result in take of endangered species, and absence is difficult to confirm, a proposal has been made to conduct cyst sampling (dry season sampling once every three years) and to collect information on the ponding of pools annually. Does this seem like a reasonable approach? What are the advantages and disadvantages of conducting monitoring through cyst collection?

See my USFWS Section 6 report (2011) with specific recommendations for cyst sampling.

8. Is annual qualitative monitoring for ponding will be sufficient to detect if new fairy shrimp establishes in vernal pools?

I'm not sure if I understand the question. But the answer is likely to be no. Simply visiting pools and looking in them may or may not tell if fairy shrimp are present. Quantitative data about wet season shrimp survey methods (including a simple visual examination) are in my USFWS Section 6 report (2011).

9. Should the triggers for changing the level of monitoring and management be species specific based upon the pilot data from the City of San Diego? For example, *Navarretia fossalis* has very low cover and would likely never move out of the 1-5% cover class so a change in this species would not trigger a change in management based on this method. Should density counts (# of individuals per pool) be used instead for this species with some percentage change in density requiring management actions?

See comment 11. And note errors within the question above. Density is not the same as total # individuals in a pool. And if # individuals is important, then why would declines in % be used, rather than declines in total number of individuals. The quantitative relationship between monitoring data, triggers, and population persistence needs to be presented.

10. Are the quantitative threat triggers proposed reasonable for fairy shrimp based on the approach proposed for collecting the quantitative data?

See my other comments. The question can't be answered without further details.

11. The proposal is to use three years with above 2/3 average rainfall to reduce variance due to low rainfall years. Does this approach make sense? Is three years sufficient? Does 2/3 seem reasonable to eliminate low rainfall years?

This question should be answered quantitatively, not based on what intuition. See comments 11 and 12. In the HGM guidebook, we used long term climate data, coupled with field surveys, to define "dry", "average" etc. rainfall years based on the hydrologic response. See Ch. 4 (p. 50-52) for example. So there are really two questions to ask. What are the precipitation patterns that lead to an "average" year? (Total amount for the season is only one aspect of this.) Second, what is the likelihood that three years in a row would all be "dry" and therefore insufficient? (Consult the long term climate record to determine this.)

12. Visual observation of cover classes (especially at low densities can be very subjective – the difference between 4 percent and 7 percent is 1 cover class but difficult to determine). Should the cover classes be broader (e.g., < 5%, 5-<25%, 25-<50%, etc...)? What are the pros and cons to conducting transect or plots work instead of visual observation % cover? Is there any literature that quantifies the error rate in visual cover class estimation?

See my comment 10.

13. Monitoring level 1 would sample 10 percent of the pools in a complex with the focal plant species and 5 percent of the pools in a complex with the focal shrimp species. Based upon the number of pools in a specific complex this may result in a low sample size. For example, the General Dynamics pools (N 8) has a total of 22 pools of which 20 have mesa mint and two have button celery. Ten percent of the 20 pools with mesa mint would mean you would sample two pools and 10 percent of the two pools with button celery would result in sampling one pool for button celery. This sample size seems too small to draw any conclusions. Please comment. From a statistical design standpoint do you have any recommendations?

My recommendations would depend on two things. First, what exactly is the goal? Is it to maximize the probability that a species of concern persists (anywhere)? That it persists in every complex? That it persists in every pool? Or that all pools are as functional as possible (in the broadest possible sense)? The sampling regime will differ depending on the answer.

TWP 3/4 implies that the goal is to maintain species of concern in every complex. (Language on pages 3 and 5 discusses the level of the complex.) Is that what the HCP goals should be? I would favor a broader set of goals.

The second aspect of this is considering the information gathered per unit of effort. Once the goals are clarified, one can contrast different amounts of sampling effort (and different monitoring methods that require similar levels of effort), and then have a clear answer to the question.

14. The 10 percent of pools with focal plant species used in Level 1 monitoring utilize preferentially selected “sentinel” pools that contain more than one focal species to reduce the number of pools requiring monitoring. If there are additional pools in a complex required beyond the sentinel pools to meet the “10 percent of pools in a complex with focal species” rule, these pools are chosen randomly. However, both the sentinel pools and the randomly chosen pools are sampled every year to provide permanent sampling locations. What are your thoughts on the use of annually randomized or the pools being permanent identified for monitoring?

See my answer to the previous question.

15. Page 12, Section 2.2.2.1. Regarding sentinel pools, there does not seem to be any guidance about selecting sentinel pools of a certain size. The criteria seem to be that they have a lot of the focal species, but it seems likely that you would want pools with sufficient populations to infer meaningful gains or losses to guide management decisions (or additional or reduced monitoring). Please comment.

Again, there needs to be a consensus on a very clear set of goals. Then these questions about sampling effort and regime can be answered.

16. Is the assessment of 10 pools or 5 percent of pools with SDFS and RFS for Level 1 and 10 pools or 10 percent of pools with SDFS and RFS for Level 2 sufficient enough to provide meaningful data on whether there are changes to species presence or absence?

This is a quantitative question that needs to be answered quantitatively using a large, long-term data set.

17. Level 1 monitoring is supposed to detect a change that would indicate a change in monitoring due to a decline in the focal species populations in the complex. Is there another approach or index to use to trigger this increase in monitoring? Do we need to have quantitative monitoring for level I or can we really rely on some aspect of the qualitative monitoring.

See answers to previous questions, and comment 11.

18. Is there any additional information that could be added to the qualitative monitoring that would avoid the need to do quantitative monitoring?

See answers to previous questions (esp. questions 3 and 5 on previous pages), and my comment 11 in the full report.

19. Do all the complexes need to be sampled in any given year? Could a design be developed to sample a subset of the complexes on a rotational basis with or without sentential pools to reduce the amount of required monitoring?

See answers to previous questions.

20. In your work with HGM, what characteristics of the pools were most correlated to the focal species? Could we monitor those characteristics and avoid monitoring the focal species (especially for fairy shrimp)?

The answers to these questions were determined quantitatively in the HGM.

21. Is the assessment of nonnative species as one cover class sufficient for Level 2 monitoring? Should one determine the five (or some number) most abundant exotics or track those of high threat?

The answers to these questions were determined quantitatively in the HGM.

1927 Fifth Avenue
San Diego, CA 92101
P 619.308.9333
F 619.308.9334
www.reconenvironmental.com

2033 East Grant Road
Tucson, AZ 85719
P 520.325.9977
F 520.293.3051

1504 West Fifth Street
Austin, TX 78703
P 619.308.9333
F 619.308.9334

2027 Preisker Lane, Ste. G
Santa Maria, CA 93454
P 619.308.9333
F 619.308.9334



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February 17, 2012

Ms. Cheryl Mason
San Diego Association of Governments
401 B Street Suite 800
San Diego, CA 92101

Reference: City of San Diego Vernal Pool Habitat Conservation Plan/San Diego Association of Governments Scientific Review Comments for Technical White Papers 3 and 4 (RECON Number 6504)

Dear Ms. Mason:

Here are my review comments on the Technical White Papers 3 and 4 (TWP). As we discussed on the phone last August, my involvement in the scientific review process is intended to provide input on the adaptive management strategies and methods outlined in the TWP. My comments focus on the adaptive management sections of the TWP, but I have provided comments regarding the monitoring methods and your list of questions as my experience allows. My comments and recommendations are listed below.

Questions for Scientific Advisors

I have comments for the following questions:

1. Have the restoration reports for projects mentioned in Section 4.2 been reviewed for any additional baseline data? If not these documents could be consulted and added to the literature review for the TWP.
2. Review of the 2006-2011 Rare Plant Monitoring Data indicates that there is variability in the response of focal species to rainfall amounts at different vernal pool complexes. The number of plants present from one year to the next is not always correlated with rainfall such that higher rainfall totals lead to the growth of more plants. The weed cover appears to be a possible factor where higher rainfall years can have fewer focal plant individuals. Based on the results presented in the Rare Plant Table, in general I think the combination of rainfall and weed cover triggers should provide an acceptable guide for the implementation of additional management actions in the three-tiered system.
3. The CRAM method provides information about the health of a wetland at a larger scale than the monitoring proposed in the TWP. CRAM looks at buffers to the site landscape connectivity and has been required by the USACE on recent projects. This method may not be necessary for this monitoring effort but it may be required by the USACE in the future.
4. Checking the City of San Diego's vernal pool inventory website, it appears that the survey data for the vernal pool baseline inventory was collected in 2003, not 2004 as stated in the

TWP. At the Brown Field reporting station on Otay mesa, total rainfall from July 1, 2002 to June 30, 2003 was 7.90 inches, which is approximately two inches below average. The four previous rainfall years were also below normal in the Otay mesa area (1998-1999, 1999-2000, 2000-2001, 2001-2002).

Even though Lindbergh Field received about average rainfall in the 2002-2003 season, the Otay area was drier than normal. Therefore, vernal pool data collected in the Otay mesa area in 2003 may not represent an adequate baseline for the pools in the southernmost portion of the County. For this area, it may be useful to collect new baseline data in Year 1. One caveat to this suggestion is that it is possible that weed invasion of the vernal pools has increased since 2003 in the absence of active management, such that developing a new baseline for weeds could result in a higher baseline cover of weeds. Before new baseline data is collected, I would suggest that some reference pools in the Otay complexes (sampled in 2003) be checked in Year 1 to determine if weed cover has significantly increased since 2003. If overall weed cover has increased since 2003, I would recommend using the baseline data that represents lowest weed cover values.

The 65 percent of normal rainfall threshold should be used with some caution, since the timing of the rainfall can be equally important as total rainfall amounts in determining the expression of the vernal pool flora in any given year. Years with lower rainfall can still be good for the vernal pool flora if the sequence of rainfall events is in close succession, and leads to ponding. It is possible that in lower rainfall years weed cover can be reduced compared to higher rainfall years and the vernal pool native can have higher population numbers.

5. The proposed monitoring plan appears to be adequate. I would just add that the interpretation of the monitoring data by the biologist is critical to implementing appropriate management actions. The biologist should have some flexibility in implementing management actions using the strict triggers suggested in the TWP. The biologist should use his or her experience in determining what actions to take, particularly in respect to annual rainfall totals.
6. Hydrologic monitoring is included in the qualitative monitoring section and the TWP says that inundation of at least three centimeters will be noted. The relationship between inundation and annual weed cover can be important for making management decisions. Will any quantitative hydrologic monitoring be included?
7. Collecting cysts for monitoring purposes also results in take as does wet season sampling. The advantage of dry season sampling is the easier scheduling as mentioned, but this method can potentially disturb the pools such that weed invasion may be encouraged by the disturbance.
8. The annual monitoring for ponding task does not replace the need for periodic shrimp surveys, since the shrimp may not be detected or be able to be identified to species by incidental observations alone.
9. In the example for *Navarretia fossalis* I believe that density counts (number of individuals per pool) would be a better measure than cover for detecting changes that should trigger additional management actions.
10. The 20 percent decrease or increase in fairy shrimp populations that trigger the change between the monitoring levels 1 and 2 and the 40 percent change for level 3 monitoring are reasonable in my opinion.

11. Yes the proposal to use three years with above 2\3 average rainfall as the approach to trigger management actions does make sense. Over a three year period trends in weed cover should be detectable over that time frame. The only caveat to this is the use of the 2/3 average rainfall as described in my comments for question 4.
12. I do not think that broadening the cover classes is appropriate since this makes the trigger less likely to occur due to the broader range of cover. The generally transect or plot work is more time consuming than visual estimates particularly for plot method. Using the visual method will likely save on monitoring costs. Also walking in the pools to sample transects or plots causes disturbance to the pools, unlike the visual method which can be done from the edge of the pools.
13. I agree that the sample sizes described here would be too low to draw any conclusions. I think sampling a percentage of pools in a complex is appropriate for larger pool complexes, but for small complexes a set minimum number of pool should be sampled. Even with a minimum number of pools to be sampled in small complexes the results may not be statistically adequate.
14. I think the permanent sampling of sentinel pools will allow the monitoring biologist to best detect trends because you watch the same pool over time. Random sampling of additional pools can be used, but in the future if this random sampling does not enable the monitoring biologist to adequately detect changes, the sampling scheme can be changed. My feeling is that changing the pools that are sampled may give some trend data for the complex as a whole, but looking at the same pools from year to year may be a more informative comparison for annual data.
15. If a proposed sentinel pool only has a small population of a particular focal species, perhaps an alternate pool should be chosen to monitor that focal species. Competitive interaction also occur between native species not just weeds so monitoring pools with an larger population of that species is preferable.
16. For fairy shrimp, the sampling for continued presence within a complex could be done on a rotational basis, such that over time all of the pools are eventually checked to document presence. The small pool sample size may not be adequate to draw statistically valid conclusions, but in my opinion it is most important to document continued occupancy of the fairy shrimp species over time.
17. As currently proposed, I do not believe that qualitative monitoring would be adequate to detect changes that would trigger changes in monitoring and management. The qualitative monitoring program would at a minimum need to include presence\absence monitoring (for shrimp only) to adequately detect changes
18. The presence of fairy shrimp could be noted during quantitative monitoring visits if the timing of the visit coincides with the life cycle of the shrimp. If the visit occurs right after the pools pond the fairy shrimp would not likely be detectable due to their small size at hatching. Also in pool complexes that also have *B. lindahli* species identification would require at least some sampling to identify the species present. It is possible that quantitative sampling of shrimp is done using a modified USFWS wet season protocol to streamline the monitoring process to save on monitoring dollars.
19. No, I do not think that all of the complexes would need to be quantitatively monitored each year. Monitoring on a rotational basis would be adequate in my opinion. As in my response to question 14 I think using sentinel pools is appropriate and will provide the best trend data at the various complexes.

20. Although my experience using HGM is limited I think that the hydrologic characteristics of the pools is the most correlated with the populations of focal species. Wet years generally help to drown weeds so that weed cover tends to be less in year with longer ponding durations. If hydrology is adequately maintained fairy shrimp should be sustained. In my opinion the focal plant species are more sensitive to stressors than the fairy shrimp. But I don not believe that monitoring other HGM characteristics of the pools will adequately replace the proposed focal species monitoring.
21. I recommend that the one cover class for all weeds be done, but it would also be helpful to determine the most abundant exotics and track those of high threat. The level of effort required to record these additional data would not add too much additional time to the monitoring effort (a few more minutes per pool) and collecting data on these weed cover values for high threat species would be valuable in my opinion.

Chapter 4 Tiered Management Approach

4.1 Management Goals and Objectives

This is a general comment about the baseline data and recovery of the focal species.

2003 baseline data may not represent the desired condition for the focal species, since there has been and continues to be degradation of vernal pool habitat due to weed invasion and other stressors. I recognize that each complex is different and will have different baseline conditions, but after the long decline and loss of vernal pool habitat, the goals should also include efforts to increase population sizes of the focal species where there have been documented declines. Setting specific long term goals for low weed cover at the pool complexes would be better for the recovery of the species than using a baseline cover of weeds derived from the 2003 data. For instance, baseline cover of weeds may have been high in a particular complex during the baseline monitoring period, but the high weed cover value should not be used as the target weed cover goal over the long term because the focal species may not be sustained at that high weed cover value.

In some cases the baseline conditions may represent a relatively low level of function and health of the vernal pool ecosystem. The long term goal of the Habitat Conservation Plan should recognize the previous declines in focal species populations and loss of habitat and make an effort to increase the population sizes, as appropriate, above the baseline level to contribute to the species recovery. Recovery implies that conditions will improve beyond the baseline conditions. It seems unlikely that conditions have improved for focal species in the absence of active management (i.e., weed control).

4.3.2 Management Level 2

For dethatching, a 20-foot buffer sounds reasonable, but the monitoring biologist should consider additional weeding distance to take advantage of natural breaks, such as shrub patches or canyon edges as applicable, if weeding a little farther from the pool would reduce the chances of reinvasion of weeds. Dethatching can be done on a rotational basis every three to five years to periodically reduce thatch based on the triggers described in the TWP.

Seed Collection/Bulking/Dispersal

One aspect of the seed bulking process to consider is the presence of potential pollinators in a greenhouse/nursery setting. Seed bulking can be an effective method to increase seed, but for species that are outcrossing and require cross pollination, potential pollinators can be limited in a greenhouse setting such that viable seed set is reduced or possibly absent. The plants used for seed bulking in outcrossing species may need to be located where pollinators are available or may need to be hand pollinated to maximize seed set. In the past, we have started vernal pool species (i.e., Otay mesa mint) in the nursery and then transported them to vernal pool complex for pollination. The plants were planted in one gallon containers, and the plants were taken to the

vernal pool complex prior to flowering, where the seed would eventually be dispersed. This will only be possible where the container plants will be secure from vandalism and access is sufficient to water and maintain the plants until the fruits are ripe. **These comments apply to both management levels 2 and 3**

Cyst Collection/Bulking/Inoculation

If the shrimp are declining in a particular pool it seems likely that some other factors affecting the hydrology or chemistry of the pool are causing the decline of the focal shrimp species. The methods outlined for bulking shrimp seem labor intensive and costly. If the pool has the appropriate hydrology to begin with (in a restored pool not previously occupied by focal shrimp species), then direct inoculation of the pool would be more cost efficient. If there is a decline in the focal shrimp population in an existing pool, it seems likely that factors such as changes in hydrology that are affecting the viability of the population. The introduction of more shrimp cysts will probably not solve the problem, since there are other site characteristics, such as hydrology, causing the decline. These issues causing the decline must be addressed, or the addition of bulked cysts could be wasting management dollars. **These comments apply to both management levels 2 and 3**

4.4.2 Weed Control

We appreciate the proposed use of different options when it comes to effective weed control. Having alternative methods of weed control gives the monitoring biologist different options, which is the core of an adaptive management strategy. Below we have included comments/suggestions for increasing the effectiveness of these methods, as appropriate.

This section states that dethatching is most appropriately performed in the winter, prior to the avian breeding season, with follow-up visits during the spring and early summer.

We would recommend adjusting this proposed schedule somewhat so that dethatching is done in the fall (September), after the end of the bird breeding season (prior to the start of astronomical winter, i.e., December 21), since the weeds are dry and best cut before any rainfall. If the dethatching is actually done in the winter season, the rains are likely to have already begun and native species, such as annual herbs, will be actively growing. If the natives are already growing, they would be negatively affected by the use of weed whips.

Since it often rains prior to astronomical winter, it is best to start follow-up weed control in the winter season prior to the weeds going into flowering. There is usually a small window of time after the first rains when weeds have germinated, but native species such as bulbs have not yet emerged from the soil; timing the first weeding efforts to this period of time will help to minimize the potential impacts to native from the use of herbicides. The weed control efforts can continue into spring and summer to control weeds that were missed on the first spray pass, to control newly germinated winter weeds, and to catch late season weeds such as tumbleweeds (*Salsola* spp.)

Dethatching

This section states that dethatching is most effective while non-native seed heads are still on the stalks, but at the typical time that dethatching is performed (in the fall), the seed heads of annual grasses and storks bill (*Erodium* sp.) have fallen to the ground months before (late spring early summer). When seeds of the weedy species have already fallen to the ground, we have used leaf blowers to concentrate the weed seeds after the dethatching and raking has been done. We concur that collection of target native seed should occur prior to dethatching, but the native seed is usually ready in late spring or early summer, months before dethatching is typically performed.

Hand Weeding

This section states that hand weeding is inefficient and relatively expensive. It is certainly more expensive, but I would not agree that it is ineffective when performed by well trained maintenance

workers. In some cases weed species such as rye grass (*Lolium* spp.) can only safely be removed by hand, since herbicide and or timely weed whipping cannot be done in the pool themselves due to the presence of sensitive plant species and/or shrimp. The language in this section goes on to state that hand weeding should only be done in pools when it can be accomplished efficiently or where other methods cannot be used. It seems likely that in most situations, where sensitive species are present in a particular pool, that other methods of weed removal cannot be used in the pools themselves (herbicide/weed whips) and the only option may be to hand pull nonnative grasses prior to seed set and dispersal.

How would the monitoring biologist determine when other methods are not appropriate and hand weeding would be the only option?

Weed Eating and Mowing

The use of a weed whip in the pools themselves during the growing season seems potentially problematic due to timing issues. Weeds can only be effectively control using this method while the plants are actively growing and prior to flowering. The potential issue is that the native species in the pools are actively growing and flowering at the same time. In larger pools, maintenance workers may have to walk into pools to effectively use weed whip, and this weed treatment method could impact existing resources just from the foot traffic.

From a practical standpoint, it would seem difficult to use mechanical mowers in a mima mound/vernal pool topography area with numerous shrubs on the mounds. Flat areas are more conducive to mowing. Thus, mowing may not be an effective method to use in an intact vernal pool complex with typical mima mound topography. Based on past experience, repeated mowing can select for low-growing weed species, such as *Erodium*, that will not be adequately controlled by the mowing. If mowing occurs early enough in the growing season, even annual grasses that typically grow upwards will begin to grow laterally as a consequence of the mowing and will still flower and set seed successfully because they grow under the level of the six- to eight-inch mowing height.

4.4.3 Seed Collection, Bulking and Dispersal

This section states that seed will be collected in the fall. The natives are often already dispersed or have fallen on the ground by fall. It may be better to say that native seeds will be collected as they ripen (not all vernal pool species ripen at the same time). Depending on the species, seeds of vernal pool species are often ripe by late spring or early summer. By waiting until fall to collect seeds, the biologist may miss seed crops of selected species. Building more flexibility into the seed collection program may be beneficial.

This section also states that bulked seed will be ready for broadcast by the following spring. We would recommend that bulked seed be held until the next fall for dispersal. This will help reduce the chance that the seeds will be eaten by granivores during the summer. Waiting to disperse the seed until immediately prior to predicted rain events in the fall or winter can reduce the loss of seeds to granivores, thereby making the seeding more effective.

4.4.4 Container Plant Production and Installation

Although this can be an effective method of reintroducing sensitive plant species to the pools, the planting of container stock will inevitably disturb the soil and cause the water in the pool to become cloudy from sediments brought up from the excavation. We recommend that if container plantings are to occur, the smallest container size that can still produce viable plants should be used so that the size of the excavation of the hole required for planting the container is minimized. This will help reduce siltation of the pool that can reduce the clarity of the water.

4.4.5 Topographic Reconstruction

In the second bullet of this section, it states that decompaction of the pools may be done as part of the recontouring. Decompaction is not likely to be necessary in complexes that support clay pan vernal pools. The annual shrink-swell cycle of the clay due to wetting and drying is generally sufficient to decompact the soils without using methods such as ripping the soil, which can promote the growth of weeds.

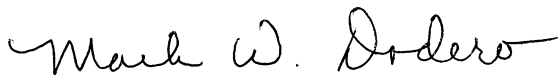
This section also calls for overgrading and then backfilling the pools with one to two inches of topsoil. If topsoil is used to backfill pools, the soil should have the same characteristics as the existing pool basin soil. Upland soils collected from the area may not be appropriate for placing in the pools if the characteristics of this topsoil is different than the pool basin soil. Upland topsoils are likely to contain a weed seed bank that would also be introduced into the pool, which may result in additional maintenance efforts being needed. We recommend that during the grading process, the top two inches or so of the existing pool soil be loosened during grading instead of introducing topsoil in soil from upland areas.

4.4.6 Restoration and Management Plan

In addition to the information included in the bulleted list for this section, the restoration and management plans should also include success criteria that relate to the goals and objectives formulated for that specific vernal pool complex so that success of the restoration and management actions can be assessed.

If you have any questions regarding these comments, please contact me.

Sincerely,

A handwritten signature in black ink that reads "Mark W. Dodero". The signature is fluid and cursive, with the first letters of each name being capitalized and prominent.

Mark Dodero
Senior Biologist

MWD:sjg

DRAFT FINAL

**TECHNICAL WHITE PAPERS 3 & 4:
ADAPTIVE MANAGEMENT AND MONITORING STRATEGY FOR
THE CITY OF SAN DIEGO
VERNAL POOL HABITAT CONSERVATION PLAN**

Prepared for:

San Diego Association of Governments Service Bureau
401 B Street, Suite 800
San Diego, California 92101
Phone: (619) 699-1951

Prepared by:

AECOM
1420 Kettner Boulevard, Suite 500
San Diego, California 92101
Phone: (619) 233-1454

Primary Authors:

Lindsey Cavallaro, Scott McMillan, Tom Oberbauer, and Linnea Spears-Lebrun

Please note that the Technical White Papers are the products of professional consultants hired by SANDAG Service Bureau, and that the City of San Diego and/or Wildlife Agencies may not concur with the recommendations contained in these reports.

August 2012

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ATTACHMENT A. Vernal Pool Complex Monitoring Form

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CHAPTER 1

INTRODUCTION

1.1 PROJECT OVERVIEW

The San Diego Association of Governments Service Bureau (SANDAG SB) will prepare a Vernal Pool Habitat Conservation Plan (VPHCP) for the City of San Diego (City) largely based on information contained in a series of Technical White Papers (TWPs). The Planning Area for the VPHCP is the geographical extent of land that will be included in the VPHCP and for which the protections provided under the VPHCP are afforded to the seven focal species. For the City's VPHCP, these lands include the entire jurisdictional boundaries of the City and three areas owned by the City's Public Utilities Department in the unincorporated portion of San Diego County (County). The Planning Area's extent is, by design, the area covered by the City's Multiple Species Conservation Program (MSCP); the VPHCP is a separate but compatible conservation plan for vernal pools and seven threatened and/or endangered focal species not covered under the City's MSCP.

Many lands included in the Planning Area are not under the local land use jurisdiction of the City. These lands could include special districts such as school districts, military lands, other federal properties, and state lands. The regulatory requirements of the VPHCP are not applicable to lands outside of the City's jurisdiction. If land ownership is transferred and subsequently comes under the City's jurisdiction, or if the owner voluntarily requests inclusion, the VPHCP regulatory requirements will be applied after undergoing the appropriate amendment process, as outlined in the VPHCP.

The TWPs focus on seven target vernal pool species consisting of five plants and two crustaceans:

- Otay Mesa mint (*Pogogyne nudiuscula*)
- San Diego Mesa mint (*Pogogyne abramsii*)
- Spreading navarretia (*Navarretia fossalis*)
- San Diego button-celery (*Eryngium aristulatum* var. *parishii*)
- California Orcutt grass (*Orcuttia californica*)
- Riverside fairy shrimp (*Streptocephalus wootoni*)
- San Diego fairy shrimp (*Branchinecta sandiegonensis*)

The eight TWP topics are as follows:

- TWP 1: Focal Species Status Update in the City of San Diego
- TWP 2: Assessment of Focal Species Conservation
- TWPs 3 & 4: Adaptive Management and Monitoring Strategy for the City of San Diego Vernal Pool Habitat Conservation Plan (a combined document)
- TWP 5: Cost Evaluation for Implementation of Management and Monitoring
- TWP 6: Recommendations for Conditions of Coverage
- TWP 7: Conservation Analysis
- TWP 8: Preserve Management Funding Mechanisms

This combined document represents TWPs 3 and 4. The purpose of this document, referred to herein as the City of San Diego Vernal Pool Management and Monitoring Plan (VPMMP), is to provide management and monitoring strategies, directives, and recommendations for all lands containing vernal pools in the VPHCP Preserve in order to preserve and/or restore their biological components, particularly the seven focal threatened and endangered species. The VPMMP provides an update to the City of San Diego's Draft Vernal Pool Management Plan (VPMP) (2009).

1.2 BACKGROUND

In 1996, the City prepared a management plan to provide direction for City-owned vernal pool sites as partial mitigation for proposed impacts from development of the SANDER property (see U.S. Fish and Wildlife Service Biological Opinion [USFWS BO 1-1-83-F-29R]). Although the site was never developed, the VPMP (City of San Diego) was completed and created the Coordinated Management Program to improve resource management among internal departments. In addition, individual vernal pool sites and/or complexes¹ were discussed in detail, including existing conditions and biological reports, threats, current management activities, and specific recommendations. The document provided guidance for land managers and for conservation of City vernal pools, but, with the exception of the two SANDER mitigation parcels, conservation measures were not required to be implemented.

In 2002, the City received a USFWS Section 6 Planning Grant to update the existing inventories of City vernal pools and the management plan for vernal pools within the City's jurisdiction. The

¹ Vernal pool complexes may include two to several hundred individual vernal pools (Keeler-Wolf et al. 1998). Typically, the pools in a complex are connected through the landscape, including the supporting watershed and upland habitats. These vernal pool complexes were given identification numbers by Bauder (1986). The numbers were updated by the City of San Diego's Vernal Pool Inventory (2004) and again by SANDAG SB (2012).

Vernal Pool Inventory was completed in 2004 and the updated City-Wide Vernal Pool Management Plan was drafted in 2006 (City of San Diego 2009).

This VPMMP updates the City's 2006 draft Vernal Pool Management Plan by developing a revised approach to adaptive monitoring and management for the City's VPHCP. The VPMMP also updates site conditions, provides current management guidance, and identifies specific management objectives at each of the 56 vernal pool complexes in the Preserve.

Directives and recommendations in this document reflect adaptive management principles, including the following elements (Figure 1-1):

- Defining management objectives
- Initial monitoring to determine baseline relative to that objective
- Implementing management actions
- Subsequent monitoring to observe the results of those actions
- Use results to adjust management actions
- Repeat monitoring and management

1.3 VPHCP GOALS AND OBJECTIVES

The biological goal of the VPHCP is to “contribute to the recovery of the VPHCP focal species and ensure continued persistence of the focal vernal pool species populations identified in the VPHCP by implementing the identified objectives.” Habitat-based and focal species-specific objectives were developed to support the VPHCP's biological goal, as detailed in Table 1-1.

Figure 1-1 Overview of Adaptive Approach to Monitoring and Management

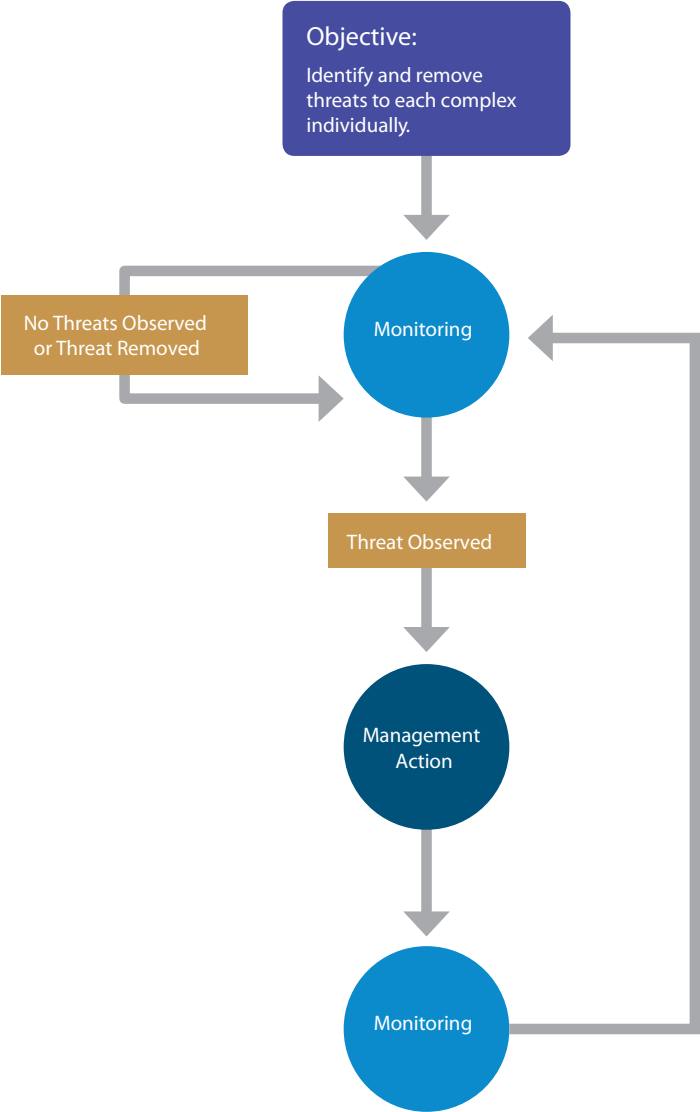


Table 1-1
City of San Diego VPHCP Biological Goals and Objectives

VP HCP Biological Goal	VPHCP Habitat Objectives	Focal Species	VPHCP Species Specific Objectives*	
Contribute to the recovery and ensure continued persistence of the VPHCP focal vernal pool species populations by implementing the identified objectives.	1. Conserve in perpetuity at least 2,019 basins totaling approximately 31.5 acres within the VPHCP Preserve through development regulations and existing conserved basins in a configuration that maintains long-term viability of the VPHCP focal species.	Otay Mesa mint	1. Conserve and manage existing vernal pool complexes and their associated watersheds currently occupied by Otay Mesa mint within the Preserve (J2, J4-5, J14, J15, J30, J32, and J 33) to maximize the likelihood that existing occurrences are sustained in the VPHCP Plan area and, in doing so, contribute to recovery of the species on a range-wide basis.	2. Conserve and restore vernal complexes identified by the USFWS Recovery Plan (1998) as necessary to stabilize Otay Mesa mint (J2, J11E, J11W, J12, J13E, J13N, J13S, J14, J16-18, J20-21, J21, J27, and J28E) to enhance genetic diversity and population stability of Otay Mesa mint.
	2. Manage in perpetuity 53 vernal pool complexes within the VPHCP Preserve through implementation of the VPHCP Management and Monitoring Plan.	San Diego Mesa mint	1. Conserve and manage extant populations across the range of existing vernal pool complexes and their associated watersheds currently occupied by San Diego mesa mint within the Preserve (B11, B6, C10-16, C17-18, C27, D5-8, H1-10, 13-15, 18-26, H39, I1, I6C, I6B, N1-4, N5-6, N8, U15, and U19) to maximize the likelihood that existing occurrences are sustained in the VPHCP area, and, in doing so, contribute to recovery of the species on a range-wide basis.	2. Conserve and restore vernal complexes identified by the USFWS Recovery Plan (1998) as necessary to stabilize San Diego Mesa mint (D5-8, F16-17, H1-10, 13-15, 18-26, H33, N1-4, and N5-6) to enhance the genetic diversity and population stability of San Diego Mesa mint.
	3. Restore 20 vernal pool complexes to a "Level 1" (stewardship) management condition within the VPHCP Preserve through implementation of the VPHCP Management and Monitoring Plan.	Spreading navarretia	1. Conserve and manage existing vernal pool complexes and their associated watersheds currently occupied by spreading navarretia within the Preserve (D5-8, J2, J4-5, J13N, J14, J15, J32, J33, K5, and X5) to maximize the likelihood that existing occurrences are sustained in the Plan area and, in doing so, contribute to recovery of the species on a range-wide basis.	2. Conserve and restore vernal complexes identified by the USFWS Recovery Plan (1998) as necessary to stabilize spreading navarretia (J2, J11E, J11W, J12, J13E, J13N, J13S, J14, J16-18, J20-21, J21, J27, J28E, K5, and R1) to enhance the genetic diversity and population stability of spreading navarretia.

VP HCP Biological Goal	VPHCP Habitat Objectives	Focal Species	VPHCP Species Specific Objectives*	
		San Diego button-celery	1. Conserve and manage extant populations across the range of existing vernal pool complexes and their associated watersheds currently occupied by San Diego button celery within the Preserve (B11, B7-8, C10-16, D5-8, H1-10, 13-15, 18-26, H33, H39, I1, I6C, J2, J4-5, J13N, J13S, J14, J15, J16-18, J27, J29, J30, J32, J33, K5, N8, and U19) to maximize the likelihood that existing occurrences are sustained in the VPHCP area, and, in doing so, contribute to recovery of the species on a range-wide basis.	2. Conserve and restore vernal complexes identified by the USFWS Recovery Plan (1998) as necessary to stabilize San Diego button-celery (D5-8, F16-17, H1-10, 13-15, 18-26, H33, J2, J11E, J11W, J12, J13E, J13N, J13S, J14, J16-18, J20-12, J21, J27, J28E, K5, and R1) to enhance the genetic diversity and population stability of San Diego button-celery.
		California orcutt's grass	1. Conserve and manage existing vernal pools and their associated watersheds currently occupied by Orcutt's grass complexes within the Preserve (J2, J13N, J14, and J15) to maximize the likelihood that existing occurrences are sustained in the Plan area, and, in doing so, contribute to recovery of the species on a range-wide basis.	2. Conserve and restore vernal complexes identified by the USFWS Recovery Plan (1998) as necessary to stabilize California Orcutt's grass (J2, J11 E, J11W, J12, J13E, J13N, J13S, J14, J16-18, J20-21, J21, J27, and J28E) to enhance the genetic diversity and population stability of California Orcutt's grass.
		Riverside fairy shrimp	1. Conserve and manage existing vernal pool complexes and their associated watersheds currently occupied by Riverside fairy shrimp within the Preserve (J2, J4-5, J11W, J14, J15, J16-18, J29, J30, J31, J32, J33, and J34) to maximize the likelihood that existing occurrences are sustained in the VPHCP area, and, in doing so, contribute to recovery of the species on a range-wide basis.	2. Conserve and restore vernal complexes identified by the USFWS Recovery Plan (1998) as necessary to stabilize Riverside fairy shrimp (J2, J11E, J11W, J12, J13E, J13N, J13S, J14, J16-18, J20-21, J21, J27, and J28E) to enhance the genetic diversity and population stability of Riverside fairy shrimp.

VP HCP Biological Goal	VPHCP Habitat Objectives	Focal Species	VPHCP Species Specific Objectives*	
		San Diego fairy shrimp	1. Conserve and manage extant populations across the range of existing vernal pool complexes and their associated watersheds currently occupied by San Diego fairy shrimp within the Preserve (B11, B7-8, C10-16, C27, D5-8, H1-10, 13-15, 18-26, H17, H38, I1, I6B, I6C, J2, J4-5, J11W, J14, J15, J29, J31, J32, J33, K5, MM1, N5-6, N8, Q2, R1, U15, U19, X5, and X7) to maximize the likelihood that existing occurrences are sustained in the VPHCP area and, in doing so, contribute to recovery of the species on a range-wide basis.	2. Conserve and restore vernal complexes identified by the USFWS Recovery Plan (1998) as necessary to stabilize San Diego fairy shrimp (F16-18, H1-10, 13-15, 18-26, H33, J2, J11E, J11W, J12, J13E, J13N, J13S, J14, J16-18, J20-21, J21, J27, J28E, N1-4, N5-6, and X5) to enhance the genetic diversity and population stability of San Diego fairy shrimp.

* Refer to TWP 2 Attachment A for details on complexes occupied by focal species (column 1), and Appendix F of the USFWS Recovery Plan for complexes identified as necessary to stabilize the focal species populations (column 2).

1.4 VPMMP STANDARDS

To achieve objectives of the VPHCP, complex-specific management actions are required to be implemented via the VPMMP. To assess the status and need for complex-specific management actions, the following standards will be implemented and monitored under the directives of the VPMMP. These standards were developed using the “SMART” method: **S**pecific, **M**easurable, **A**chievable, **R**esults-oriented, and **T**ime-fixed (Adamcik et al. 2004). These standards will be implemented through complex-specific management and monitoring directives (currently being developed by the City).

These standards will be used to assess all conserved vernal pools monitored under the tiered adaptive monitoring and management approach described below, and to assess the success of complex-specific management actions.

- A. Annually identify threats (invasive species, trampling, off-road-vehicle [ORV] activity, etc.) in all pools monitored, and implement actions to prevent or reduce those threats.
- B. Prevent an average decline of at least one cover class of any focal plant species over 3 years for years having at least 65% average rainfall.
- C. Prevent a 20% decline in the density of the focal shrimp species over 3 years.
- D. At complexes with 10% or greater average total nonnative species cover, prevent an increase in one cover class for nonnative cover over 3 consecutive years, regardless of rainfall.
- E. Maintain vernal pool hydrological network (i.e., inlet and outlet features) and water storage (maximum depth within +/-10% of baseline) functions.

Annual monitoring (as detailed in Section 2.0) will evaluate success of implemented actions and inform adaptive management decisions.

1.5 VPMMP OVERVIEW

The VPMMP uses a tiered three-level approach to adaptive monitoring and management that is applied to individual vernal pool complexes. The levels are linked to the VPMMP standards and are assigned at the complex level based on evaluation of the existing habitat conditions and population status of the seven focal species within a complex. The goals of complex-wide monitoring and management at each level are as follows:

-
- Level 1 – *maintain* existing habitat conditions and existing focal species population status
 - Level 2 – *stabilize* focal species population status by improving habitat conditions to a level that can support existing populations
 - Level 3 – *remediate* declining focal species population status by improving habitat conditions to a level that can support baseline (defined below) focal species populations

The monitoring and management actions required by each level are determined by triggers directly tied to the objectives above (Figure 1-2). Monitoring and management levels are implemented complex-wide and apply to particular population conditions within the complex. For example, a complex with a stable or increasing focal species population will be *maintained* in that condition, requiring the least monitoring and management effort (Level 1). But a population within a particular complex that is declining considerably will need *remediation*, which requires the highest level of monitoring and management effort (Level 3).

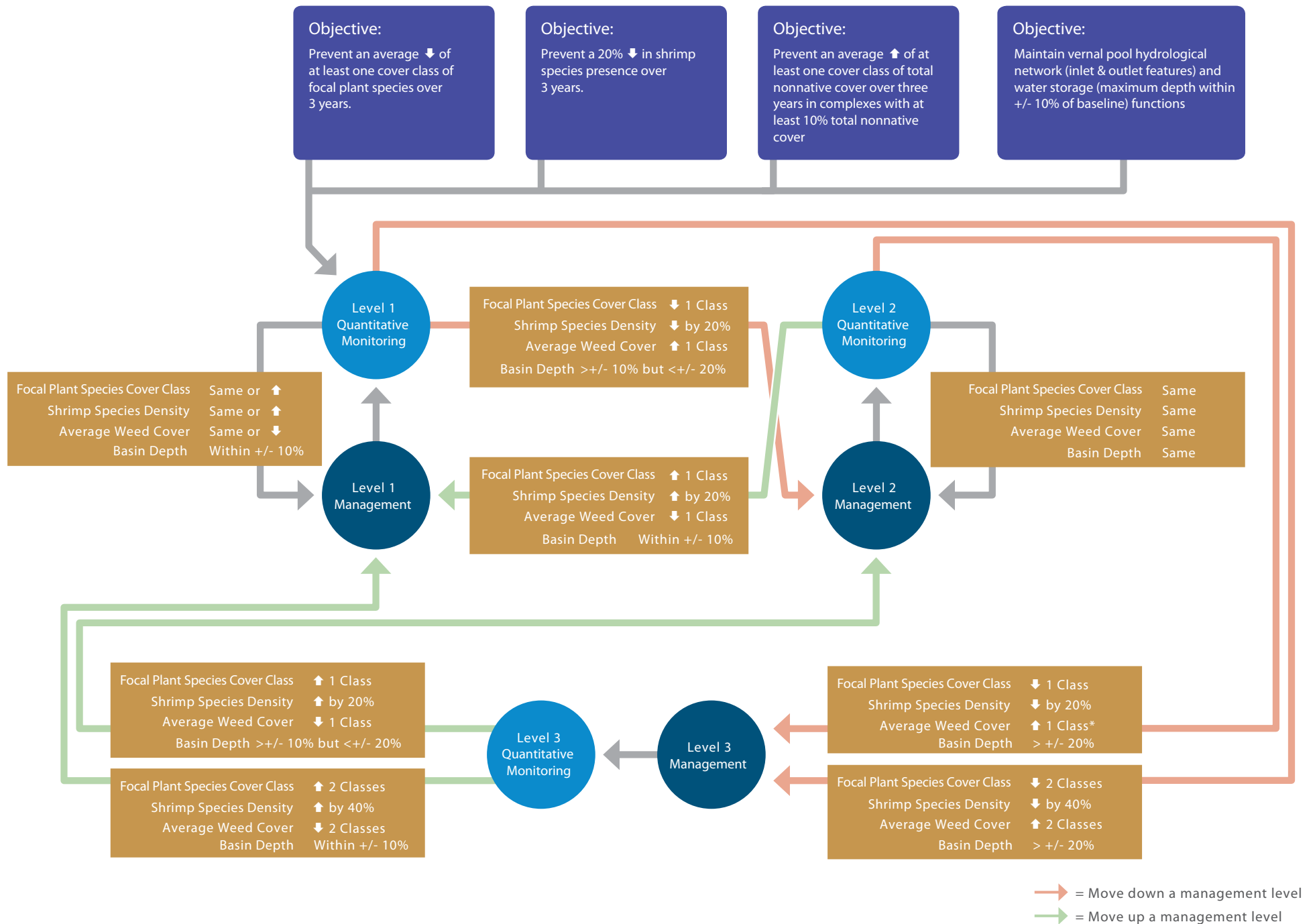
The City’s 2004 Vernal Pool Inventory (City of San Diego 2004) will serve as the baseline for comparison to maintenance triggers for each complex. In the future, where/if more recent data exists and is available, the more recent data will be used as the baseline for comparison to the maintenance triggers.

Specific details on monitoring methods, maintenance activities, and triggers can be found in Chapters 2 through 4. Chapter 2 describes the necessary monitoring methods used for each level of monitoring. Chapter 3 describes the triggers for management actions based on the data collected during monitoring. Chapter 4 details the necessary management actions to be taken based on the triggers for each level of maintenance. Necessary actions are those that are required to conserve and protect populations of each of the seven focal species under the VPHCP.

Chapter 5 contains a description of “desired” actions to achieve a fourth level to *expand* the populations of each of the focal species at specific complexes managed under this VPMMP. Achieving that goal will require implementing additional “desired” monitoring or management actions, which are not required under the VPHCP. Desired actions are those that may require additional research to implement, including actions that are necessary to expand the populations of each of the focal species. Where appropriate, desired actions will be implemented via grants or other types of alternative funding sources.

Figure 1-2 Tiered Adaptive Monitoring and Management Approach

VPMMP Goal: Stabilize and Preserve Seven Focal Species Populations



CHAPTER 2

TIERED MONITORING APPROACH

2.1 OVERVIEW OF MONITORING METHODS

The monitoring methods and sampling design for the VPMMP were developed with the intent to collect data necessary to evaluate the VPMMP standards (Section 1.4) and, thus, determine if the VPHCP objectives are being achieved. The monitoring methodology described in the VPMMP allows for time- and cost-effective monitoring and data collection that evaluates and adaptively revises management actions based on management triggers (defined in Chapter 3). The data collected under the VPMMP is not intended for statically rigorous evaluation of vernal pools, but, rather, to efficiently collect data to effectively inform management decisions with the ultimate purpose of achieving the VPMMP standards. The VPMMP monitoring program assesses overall vernal pool habitat and the seven focal species populations at a complex-wide level within the VPHCP Preserve. The VPMMP monitoring methodology was developed based on best-expert opinion and expertise, drawing on and adapting from applicable elements of various existing methods for evaluating vernal pool habitat, as well as over ten years of experience monitoring and managing hundreds of vernal pools throughout San Diego County. The monitoring methods in the VPMMP are designed to be implemented by qualified consultant or City staff with minimal input from vernal pool experts.

The purpose of VPMMP monitoring is to guide management actions for the VPHCP Preserve and determine if the VPHCP objectives are being achieved. While regional population analysis for the focal species is not part of the VPMMP (because it is not an objective of the VPHCP), the monitoring data collected for the VPMMP can be used to support population trend analysis for the focal species within their larger range (i.e., beyond the boundaries of the VPHCP Preserve). Refer to Section 2.4 for more detail.

Several key methods have been used or been proposed for use in monitoring vernal pool habitat, including the Hydrogeomorphic Model (HGM), California Rapid Assessment Method (CRAM), and USFWS protocols. Applicable elements from each of these methods have been adapted and integrated into the VPMMP, as discussed below.

The Hydrogeomorphic Model (HGM)

Developing assessment methods that are both accurate and practical in application is challenging due to the variability of wetlands, including vernal pool habitat. Many methods for assessing

wetlands are relatively rapid but often lack the resolution necessary to detect significant changes in wetland functions. To achieve an appropriate level of detail in a short time frame, a more restrictive set of data needs to be considered. This is the primary goal of the HGM classification: to identify the most useful data for a comprehensive evaluation. The HGM classification method identifies groups of wetlands that function similarly using three criteria: geomorphic setting, water source, and hydrodynamics. Geomorphic setting refers to the landform and position of the wetland in the landscape. Water source refers to the primary water source in the wetland, such as precipitation, groundwater, or overland flow. Hydrodynamics refers to the level of energy and the direction that water moves through the wetland (Bauder et al. 2009).

The HGM approach has been applied to a wide range of wetland habitat types to develop functional indices to assess wetland functions and health (Brinson 1993; Smith et al. 1995). Recently, an HGM model was developed specifically for the vernal pool ecosystems in Southern California (Bauder et al. 2009). With this methodology, users can assess the functional capacity of the selected wetlands and also assess them using a regional guidebook that offers standardized methods and evaluation protocols.

The HGM approach was originally conceived for use in a regulatory context, but it also has a variety of other potential applications, including evaluation of ecosystem restoration and preserve management. The HGM approach can also be applied as part of an overall planning context where it can be used to measure impacts to existing wetlands, locate and evaluate potential restoration sites, or evaluate the effectiveness of habitat management efforts and suggest corrective actions. However, the HGM approach is not necessarily practical for implementation across the entire City VPHCP Preserve for the following reasons:

- The HGM's five direct Function Indices measure and analyze data that is difficult to associate with real-world observations and conditions. Real-world observations and conditions are the best indicators for habitat health and focal species population viability. Data collection and analysis for habitat and species population conditions should be practical yet still provide the information necessary for management decisions. Once data is subjected to more complicated analyses, it becomes more difficult to interpret in reference to habitat conditions, species health, and the management that should be applied. Data collection and analysis do not have to be complicated or highly technical to provide valuable input for management decisions.
- The type of monitoring and analysis prescribed in the HGM approach requires advanced technical skill and is time-intensive, and, thus, costly.

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- The HGM's five indirect Function Indices provide a qualitative and efficient method for monitoring, but are based on substantial assumptions, the results of which are too inconclusive to use to adequately identify management needs.
 - The primary parameter for Function 4 (Maintain Characteristic Plant Community) is diversity of native plants in the pools. HGM does not provide any methods to collect data on the percent cover or the population size, both of which are valuable parameters for tracking the health of the focal plant species.
 - Similar to Function 4, the primary parameter for Function 5 (Maintain Characteristic Faunal Community) is crustacean species diversity. There is no parameter for overall population size and health. In addition, data collection for the faunal components requires extensive wet season sampling that is prohibitive for annual monitoring requirements in terms of cost and resources.
 - While the HGM methods, analysis, and Function Indices are based on 10 years of scientific effort, that effort was limited to sampling a very small number of pools for each function. For Functions 1 and 2, a total of 45 pools were analyzed, for Function 4, 61 pools were assessed, and for Function 5, only 28 pools were analyzed.

Certain aspects of the HGM approach are useful in the context of the VPMMP because the fundamental evaluation criteria are based on the geomorphic and hydrologic setting of vernal pools (i.e., the vernal pool complex). The purpose of the VPMMP is to evaluate vernal pool habitat and focal species at a complex level. Two of the HGM functions, Function 1 (Surface and Sub-Surface Water Storage) and Function 2 (Hydrological Networks), have been adapted for use in the VPMMP monitoring methodology. The hydrological network features (basin inlets/outlets) and certain hydrological features relating to water storage (depth) for each vernal pool are monitored as part of the VPMMP program.

California Rapid Assessment Method for Wetlands (CRAM)

CRAM requires collecting coarse data for monitoring wetland conditions. CRAM has been in development over the last 5-plus years in collaboration with the resource agencies and scientists throughout California. The overall goal of CRAM is to "provide rapid, scientifically defensible, standardized, cost-effective assessments of the status and trends in the condition of wetlands and related policies, programs, and projects throughout California." Vernal Pool Systems and Individual Vernal Pools are two wetland sub-types that have developed field books under CRAM (CWMW 2012a, b, and c).

A CRAM score, regardless of wetland type, is composed of four main attribute scores: buffer and landscape context, hydrology, physical structure, and biotic structure. The attributes are divided into metrics and sub-metrics that are scored based on defined conditions. The metrics, sub-metrics, and condition scores vary based on the wetland type being assessed (some sub-metrics do not apply to all wetland types). The final CRAM score is the sum of the four attributes scores, which is then converted to the percentage of the maximum score achievable, theoretically ranging from 0 to 100%. The overall CRAM score is often less informative than the more specific metric and attribute scores when interpreting site conditions.

CRAM has been calibrated throughout California and in various wetland types. Therefore, CRAM scores can be compared for sites across California within the same wetland type. CRAM is designed to collect a coarse assessment of the site's ambient condition, but can also be used to measure progress toward meeting success criteria established for wetland function/condition. However, similar to HGM, CRAM in its full application is not practical for a Preserve-wide monitoring program; it is time-consuming and requires advanced technical skill, and does not adequately track population viability over time. Many of the issues associated with the use of CRAM are similar to those discussed above under the HGM approach. However, the qualitative monitoring in the VPMMP does incorporate some of the parameters used in CRAM, such as disturbance types and general habitat conditions (see Attachment A).

USFWS Protocol Assessments

USFWS has specific methods and guidance for conducting assessment for the focal crustacean species (San Diego fairy shrimp and Riverside fairy shrimp). Currently, all wet season surveys for the focal crustacean species must be conducted by a permitted biologist and pursuant to the Interim Survey Guidelines to Permittees for Recovery Permits under Section 10(a)(1)(A) of the Endangered Species Act for the Listed Vernal Pool Branchiopods (USFWS 1996). USFWS protocols for shrimp surveys primarily capture presence/absence data for the focal shrimp species. Currently, the protocol requires a rough qualitative estimation of population size (USFWS 2009).

According to the USFWS protocol, following the conclusion of fairy shrimp surveys, all of the pools within a project area must have been subject to either one wet season survey or one dry season survey, at a minimum. If winter rains are insufficient to inundate vernal pools, dry season surveys can also be completed. Dry season sampling follows the Andrew Bohonak method of extracting DNA from shrimp cysts (Vandergast et al. 2009). Dry season cyst sampling is incorporated into the VPMMP as a method for measuring shrimp density.

2.2 VPMMP TIERED MONITORING APPROACH

The tiered three-level monitoring approach requires both qualitative and quantitative monitoring at vernal pool complexes within the VPHCP Preserve. Monitoring will be performed on City-owned lands that are under the City's land use jurisdiction.

Qualitative monitoring corresponds to documenting observations during annual site visits, as well as incidental observations during management activities (e.g., weed control). For all monitoring levels, qualitative monitoring will occur at each complex to identify and document threats to the complex such as invasive plants, dumping, ORV activity, and trampling.

Quantitative monitoring involves activities such as mapping and estimation of species cover, population size/density, and presence/absence at each complex. Quantitative monitoring requirements vary based on the three levels of monitoring, with higher levels collecting more data with greater precision to inform management actions. More data collection requires greater effort and cost. The decision to move to a higher monitoring level is based on triggers directly tied to the objectives stated in Chapter 1. More detail on the triggers can be found in Chapter 3.

Table 2-1 provides an overview of the sample size and monitoring methods for each level of monitoring. More detail is provided on the monitoring methods (Section 2.2.1, Qualitative, and 2.2.3, Quantitative) and the approaches associated with each of the three monitoring levels (Sections 2.2.3.1 through 2.2.3.3) in the sections below.


Table 2-2 illustrates an example of the annual monitoring cycle for Level 1 (Stewardship). As shown, each vernal complex with the Preserve would generally be visited at least monthly for 10 months of the year. Vernal pool complexes on Otay Mesa and Del Mar Mesa would be visited monthly throughout the year, per a recommendation from USFWS for those complexes.

Table 2-1
Tiered Monitoring Approach

Level	Sample Size	Frequency and Timing	Monitoring Method
Qualitative			
	All complexes	Three visits annually during wet season	Threat assessment and pool inundation verification
Quantitative			
Level 1	Baseline hydrologic survey	Once	Measure maximum pool depth, pool inlet and outlet, and geomorphic setting of complex
	10% of pools in each complex with focal plant species If complex has <10 pools for each focal species, survey at least one pool for each focal species known to occur	Annually, spring	Collection of cover class data of each focal plant species and each nonnative plant species
	Up to 10 pools or 5% of pools with focal shrimp species, whichever is greater	Every 3 years, dry season	Dry season sampling with genetic identification of cysts
Level 2	Baseline hydrologic survey	Once	Measure maximum pool depth, pool inlet and outlet, and geomorphic setting of complex
	All pools in complex with focal plant species	Annually, spring	Collection of cover class data of each focal plant species and each nonnative plant species
	Up to 10 pools or 10% of pools with focal shrimp species, whichever is greater	Every 3 years, dry season	Dry season sampling with genetic identification of cysts
Level 3	Baseline hydrologic survey	Once	Measure maximum pool depth, pool inlet and outlet, and geomorphic setting of complex
	All pools in complex with focal plant species	Annually, spring	Collection of cover class data of all native plant species and each nonnative plant species
	Up to 10 pools or 20% of pools with focal shrimp species, whichever is greater	Every 3 years, dry season	Dry season sampling with genetic identification of cysts

Table 2-2
Example Annual Schedule of Site Visits for Level 1 Monitoring and Management (Stewardship)

Task	January	February	March	April	May	June	July	August	September	October	November	December
Overview of Site Visit Timing												
MONITORING LEVEL 1												
Qualitative Visit												
Quantitative Floral Surveys												
Quantitative Shrimp Surveys												
Ponding Verification												
MANAGEMENT LEVEL 1												
Access Control Patrol/Access Repair									*	*		
Trash and Debris Removal (If Needed)												
Edge Effect Repair (If Needed)												
General Weed Control Level 1												
Vernal Pool Weed Control Level 1												
Maintenance Oversight												

 Indicates site was visited

*For vernal pool complexes on Otay Mesa and Del Mar Mesa only because monthly visits are required per USFWS.

2.2.1 Qualitative Monitoring

Regardless of the designated monitoring level, annual qualitative monitoring will be conducted at each applicable vernal pool complex within the VPHCP Preserve (refer to TWP 2 Attachment A). This includes complexes on conserved lands that the City owns and lands under the City's land use jurisdiction (where legal access is available). General site assessment information will be collected, including current or potential threats (invasive species, edge effects, fire, and others), and recommendations for management will be generated.

Each complex will be assessed for the following conditions and threats:

- Fencing and Signage: The conditions of fencing or other site protection measures will be checked to verify that the site is secured and that appropriate signage is in place.
- Edge Effects: Each complex will be inspected for edge effects from landscaping (irrigation runoff, invasive species, herbicide application, etc.), water drainage (water quality, increased ponding, etc.), dust production, dumping, and other issues within the complex or on adjacent properties.
- Fire and Fire Suppression: Evidence of fire or disturbance from fire suppression will be evaluated for impacts to the site (loss of native habitat, weed invasion, erosion, etc.).
- Trespass: Each complex will be inspected for signs of trespass or illegal ORV activity.
- Topographic Disturbance: Each complex will be evaluated for topographic disturbance or altered hydrology from vehicle damage, illegal trespass, or other landscape-damaging impacts. The qualitative assessment of topographic disturbance will evaluate the following:
 - Pool integrity and hydrologic function
 - Shape and size of the disturbance and the overall pool
 - Depth and duration of ponding
 - Need for hand work or mechanical equipment for repairs
 - Need for watershed analysis and/or microtopographic plans
- Invasive Species: A general assessment of nonnative plant and animal invasion will be made during each qualitative survey for the vernal pool and upland areas. Observations of invasive plant species and invasive wildlife presence will be noted.

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- Inundation: A visual check for pool inundation will be performed; inundation of at least 3 centimeters (cm) in depth will be noted.
 - Other: Any additional observed disturbances that could affect habitat quality

In addition, the overall disturbance category of the complex will be identified, based on the disturbance categories defined in the HGM Manual (Bauder et al. 2009). The categories range from minimal/no disturbance to sever disturbance. Refer to Attachment A for more detail.

The qualitative monitoring described above will be conducted every year regardless of the level of rainfall received. Visits should occur in the winter and spring seasons (generally February through May). Qualitative monitoring can be conducted in conjunction with the quantitative monitoring described below.

An example of a combined qualitative and quantitative monitoring form that can be used for data collection is included as Attachment A. This form incorporates disturbance categories from the HGM Manual (Bauder et al. 2009), as discussed above.

In addition to an annual threat assessment, each vernal pool complex with focal shrimp species will be visited up to three times a year during the wet season to check for pool inundation. These visits will be timed to occur following a large rain event when inundation of the pools is expected. Inundation of at least 3 cm in depth will be noted.

2.2.2 Baseline Hydrologic Surveys

Baseline hydrologic surveys will be conducted for all vernal pools within all complexes in the VPHCP Preserve, regardless of the assigned VPMMP monitoring and management level. Baseline surveys will involve measuring maximum basin depth and basin inlet and outlet locations using a laser transit. Baseline hydrologic data will serve as a benchmark from which to evaluate potential topographic and/or hydrologic disturbance observed during monitoring (tied to VPMMP Standard “E” in Section 1.4). Baseline hydrologic data will be used to guide management decisions at Levels 2 and 3 (see Chapter 4) to repair observed topographic and/or hydrologic disturbance and restore hydrologic function.

Baseline hydrologic surveys could be performed across the VPHCP Preserve over 1 year, or over several years, depending on City staff and funding availability. If surveys occur over multiple years, it is recommended that the City prioritize Level 2 and 3 complexes for baseline hydrologic data collection.

2.2.3 Quantitative Monitoring

Regardless of the assigned monitoring level, each applicable complex within the Preserve will have some quantitative monitoring conducted each year. Surveys should be timed to coincide with the appropriate ecological conditions for the target species. For the focal plant species, timing should coincide with the optimal flowering time later in the season when detection and identification of both early and late vernal pool plant species are possible. For the focal shrimp species, cyst collection visits should occur during the dry season.

The monitoring level will determine whether only the focal plant species will be assessed or whether all of the plant species in the pools (with focal species) will be assessed. Monitoring will include cover estimates within the pool basins using cover classes taken from the California Native Plant Society's (CNPS) plant cover methodology. The City began using the CNPS cover class methodology in 2006 to collect data on vernal pools following the McEachern et al. MSCP rare plant monitoring protocol (McEachern et al. 2006). This methodology was also used during the Vernal Pool Inventory of the City's vernal pool complexes (City of San Diego 2004). With this methodology, estimated absolute percent cover of each focal plant species in a pool is grouped in the following classes to track changes in cover over time: <1%, 1–5%, 5–10%, 10–25%, 25–50%, 50–75%, and 75%+. Use of the CNPS class system allows for valuable data collection without the time required for other types of vegetation assessments (transects, plot-frames, etc.). In addition to the focal plant species, other native and nonnative vegetative cover can be estimated with the CNPS class system. More detail on this method is provided below under each of the monitoring levels.

For the focal shrimp species, dry season sampling of cysts with genetic identification to species will be used.

Monitoring for floral and faunal components will be conducted from the pool margins so that trampling of vernal pool resources and the inadvertent transferring of vernal pool propagules (plant seeds and shrimp cyst) are minimized.

At any complex, if topographic or hydrologic disturbance is observed in a vernal pool during qualitative monitoring (Section 2.2.1), then maximum basin depth will be measured and inlet and outlet locations will be recorded to compare against baseline hydrologic data (Section 2.2.2). If topographic reconstruction is required (Management Level 2 or 3; refer to Chapter 4), then monitoring will be performed (Level 2 or 3) to determine if restored hydrological function achieves the VPMMP Standard "E" (Section 1.4).

These methods can be revised if new or improved methods are established. However, it is important that any new methods provide comparable data for evaluating the success of the VPMMP and for long-term trend evaluations. The new methods should also be comparable in cost.

2.2.3.1 Monitoring Level 1

Monitoring Level 1 includes all aspects of the qualitative monitoring described above, as well as quantitative monitoring for a subset of the vernal pools containing focal species at each applicable complex in the Preserve (refer to TWP 2 Attachment A). At Monitoring Level 1, 10% of the vernal pools with focal plant species will be assessed quantitatively using the CNPS class system described above. If a complex has less than 10 pools for a particular focal species, survey will take place for at least one pool where that focal species is known to occur. Only the focal species will be assessed in each pool. Pools in a given complex with more than one focal species will be preferentially chosen to reduce the total number of pools required for sampling. These intentionally chosen pools are considered sentinel pools. If all focal plant species in a complex do not co-occur in the same pools, the remaining needed pools will be chosen randomly in each complex to meet the 10% criterion. The sentinel pools and the randomly chosen pools will then be sampled every year to provide greater precision in changes observed in cover class estimates. While not random, the use of sentinel pools with multiple focal plant species, as well as the use of permanent sampling, will increase the efficiency and precision of monitoring at Level 1.

The following is a hypothetical example that demonstrates the application of the 10% sample size and sentinel/random pool selection methods. Table 2-3 also details this example. A complex is known to contain 100 pools. Of those, 30 pools have San Diego button-celery, 20 pools have San Diego mesa mint, and five pools have spreading navarretia. Some pools contain more than one focal species. Based on the 10% rule, three of the 30 San Diego button-celery pools and two of the 20 San Diego mesa mint pools should be monitored. One of the five spreading navarretia pools in this complex should be monitored, since fewer than 10 pools have this particular focal plant species. If two pools in the complex contain all three species, these two pools would be preferentially chosen to be monitored and serve as sentinel pools. A third pool containing San Diego button-celery would be chosen randomly from the 30 pools known to contain San Diego button-celery to complete the required monitoring at this example complex. In this hypothetical monitoring year, three pools would fulfill the requirement for monitoring under Level 1, and these three pools would then be sampled every year that this hypothetical complex is at Monitoring Level 1.

Table 2-3
Monitoring Level 1 Example Vernal Pool Complex Sampling Selection

Complex Characteristics	Number of Pools ¹	Sample Size (10% or at least 1 pool if <10 pools)	Permanent Pool Selection ²
Number of pools out of 100 with all 3 focal plant species	2	-	2 (Preferential selection of these two sentinel pools would satisfy sample size requirements for Otay Mesa mint and spreading navarretia, and 2 of 3 San Diego button-celery pools).
San Diego button-celery pools	30	3	1 (Randomly select 1 additional pool from these 30 to satisfy requirement for 3 total San Diego button-celery pools.)
Otay Mesa mint pools	20	2	-
Spreading navarretia pools	5	1	-
Pools with no focal species	45	-	-
TOTAL	100	6	3

¹ Based on the number of occupied pools detected the previous monitoring year, or, for the first year of monitoring, based on the City's vernal pool database (2012), summarized in TWP 2 (AECOM 2012).

² Pools for permanent sampling will be selected for each complex the first year a complex is part of Monitoring Level 1.

At Monitoring Level 1, nonnative species cover will be assessed using the CNPS class system; however, all nonnative species will be aggregated into one cover class estimate for comparison to the triggers. Individual nonnative species and problematic invasive exotics should be listed on the monitoring form (Attachment A) to direct management actions directed at nonnatives.

For the two focal shrimp species, monitoring will include dry season sampling for shrimp cysts that will be genetically identified to species. For Monitoring Level 1, 5% of the pools at each complex with the focal shrimp species will be sampled once every 3 years.

An estimate of density for each focal shrimp species can be calculated as the number of cysts per volume of soil. The change in density can be tracked over time as an indicator of the population size of the pool. If the average cyst density decreases across the occupied pools in a complex, it can be inferred that the focal shrimp population is decreasing at that complex. Similarly, if the average cyst density increases across the occupied pools in a complex, it can be inferred that the population is increasing at that complex. Sampling for shrimp cyst density and identification

will be done in accordance with the USFWS protocol, as modified by Dr. Bohonak at San Diego State University (USFWS 1996; Bohonak and Simovich 2011), using the following guidelines:

- Samples should be collected within 1.0 meters from the pools lowest point where shrimp cyst densities are the highest.
- Set up two perpendicular transects so that they intersect in the pool's deepest spot, and one transect should pass over the pool's second deepest point.
- Five core samples (2 inches in diameter and 2 inches deep) should be collected per pool as follows: one in the pool center, and one radiating out 1.0 meter in each of the four transect line directions, for a total of five samples per pool.
- The cores samples should be taken when the pools sediments is completely dry at the surface and subsurface.
- Core samples should be processed in the laboratory using standard washing protocol and cysts should be removed from the damp soil by trained personnel under a dissecting microscope.

2.2.3.2 Monitoring Level 2

At Monitoring Level 2, all pools with focal plant species will be assessed quantitatively using the CNPS class system. Pools without focal species will not be assessed; only the focal species will be assessed for each pool.

At Monitoring Level 2, individual nonnative species cover will be assessed using the CNPS class system described for the focal species; however, all nonnative species will be aggregated into one cover class estimate for comparison to the triggers. Individual nonnative species and problematic invasive exotics will be listed on the monitoring form (Attachment A) to direct management actions for nonnatives.

For the two focal shrimp species, San Diego fairy shrimp and Riverside fairy shrimp, monitoring for shrimp cyst density will be the same as in Monitoring Level 1. However, 10% of the pools at each complex with the focal shrimp species will be sampled every 3 years.

If topographic reconstruction is performed under Management Level 2 (Section 4.3.2) to repair observed topographic or hydrologic disturbance, monitoring will be conducted to compare restored hydrologic function (measured by maximum pool depth and inlet/outlet location) to baseline hydrologic data.

2.2.3.3 Monitoring Level 3

Monitoring Level 3 includes all aspects of the qualitative monitoring described above, as well as quantitative monitoring for all complexes in the Preserve assigned to Management Level 3 (i.e., remediation). For Monitoring Level 3, monitoring will occur only in pools with the focal species. However, the assessment will include all plant species occurring in those pools, including native (endemic vernal pool plants and upland species) and nonnative plant species.

For the two focal shrimp species, San Diego fairy shrimp and Riverside fairy shrimp, monitoring for shrimp cyst density will be the same as in Monitoring Levels 1 and 2. However, 20% of the pools at each complex with the focal shrimp species will be sampled every 3 years.

If topographic reconstruction is performed under Management Level 3 (Section 4.3.3) to repair observed topographic or hydrologic disturbance, monitoring will be conducted to compare restored hydrologic function (measured by maximum pool depth and inlet/outlet location) to baseline hydrologic data.

2.3 USE OF FOCAL SPECIES MONITORING DATA TO SUPPORT REGIONAL POPULATION TREND ANALYSIS

Monitoring methods for the VPMMP are designed to identify trends in population decline and habitat degradation at the individual basin and complex level, which is tied directly to the VPHCP goals and objectives (see Table 1-1). Since many of the complexes are geographically isolated from each other because of gaps in habitat connectivity, it is generally appropriate for monitoring and management to be implemented specific to an individual complex. If, at some point, all of the complexes are stable and maintain Level 1 (Stewardship) status, then it will be assumed that the focal species populations are stable and that there would be value to tracking the focal species' populations regionally. Evaluation of regional population trends for the focal species is not an objective identified in the VPHCP and, therefore, is not a component of the VPMMP. However, qualitative and quantitative data that is collected for each complex can be aggregated as part of a regional trend analysis performed by USFWS or others.

CHAPTER 3

MANAGEMENT ACTION TRIGGERS

3.1 MANAGEMENT ACTION TRIGGERS INTRODUCTION

The tiered monitoring program described in Chapter 2 will be used to evaluate site conditions in individual pools with focal species in each applicable complex within the VPHCP Preserve (refer to TWP 2 Attachment A) to determine the appropriate monitoring and management level.

Rainfall amounts will determine whether the vernal pool flora and fauna are adequately expressed to determine focal species population status. The benchmark for annual survey assessments comparable to the triggers will be 55% of the average rainfall for San Diego, as recorded at three weather stations throughout San Diego County, as detailed in Table 3-1.

Table 3-1
Weather Station and Average Rainfall Information

Region	Regional Transportation and Precipitation Station	Average Rainfall (Year Range)	55% of Normal Rainfall (July through June)
North	Oceanside Harbor	10.63 inches (1909 through 2010)	5.85 inches
Central	San Diego Lindbergh Field	10.18 inches (1914 through 2010)	5.60 inches
South	Chula Vista	9.75 inches (1918 through 2010)	5.36 inches

Source: <http://www.wrh.noaa.gov/sgx/cpm/station.php?wfo=sgx>

According to the HGM approach, approximately 55% of normal rainfall should be considered the minimum to express the full ecological parameters required for vernal pools in Southern California (Bauder 2009). For the VPMMP, the minimum rainfall required for adequate assessments is 55% of normal rainfall for the appropriate region for the period of July through June. The 55% of average rainfall years do not need to be sequential. Quantitative monitoring will be conducted annually, regardless of rainfall; however, only those years with 55% average rainfall will be compared to the triggers described below.

3.2 QUALITATIVE THREAT TRIGGERS

Regardless of the complex monitoring level or rainfall amount, qualitative monitoring will be conducted at each applicable complex in the Preserve to collect general site assessment information. The general existing conditions will be assessed, along with current or potential threats (development, invasive species, edge effects, fire, and others); recommendations for management will then be made for City staff or other managers to implement.

The qualitative assessments will be compared to the qualitative threshold triggers defined below. These triggers are more subjective than those that are tied to the quantitative triggers to allow responsive, flexible management. Any problems noted during qualitative assessment should be addressed immediately (or after pools have dried, to avoid damage), regardless of the time of year, the other types of management recommended for the site, or the results of quantitative monitoring.

Fencing and Signage

If, during a qualitative assessment, problems are identified with site protection measures (such as gaps cut in fencing or barriers, locks destroyed, signage damage or removal), recommendations will be made to address the issues (e.g., repair fencing, replace signs).

Edge Effects

If issues with edge effects are documented, recommendations will be made to the City or other land manager to address the problem. This may include changes to irrigation design or schedule, modification of landscape species, erosion-control measures, dust-suppression measures, and other adaptive efforts. If problems are being caused by adjacent land use and management, the City or other land manager will contact adjacent property owners/managers to address the issues.

Fire and Fire Suppression

Vernal pool sites that have burned in the last 15 years have shown a wide range of habitat recovery, from full recovery of the ecosystem to complete type-conversion to nonnative habitat. Most fire ecology experts believe that the greatest threat to managed resources is an increase in fire frequency, which has been documented in San Diego in the last 10 years. The major threat posed by a high-frequency fire regime is loss of native vegetation. Chaparral, coastal sage scrub, and native grassland vegetation may require two or more decades of fire-free conditions to recover fully. While vernal pools do not require as much recovery time, vernal pool habitat is

directly impacted by problems in adjacent upland watersheds resulting from high fire frequency, such as displacement of native vegetation with alien annual grasses and forbs, which can lead to increased flammability, decreased slope stability, and loss of biodiversity (Keeley et al. 2005, 2009).

Following a fire, quantitative data should be carefully evaluated to identify short- and long-term impacts. Impacts from fire-suppression (e.g., vehicle damage, contamination from fire-suppressant chemicals) should be addressed promptly.

Trespass

During qualitative assessment, any signs of trespass by pedestrians, bicycles, ORV activity, or equestrian use will be assessed for damage. Unauthorized trails will be closed and signage installed where appropriate. Any damage that alters hydrology will be assessed, and measures will be implemented immediately to resolve the problem.

Topographic Disturbance

Qualitative assessment of topographic and/or hydrologic disturbance will include recommendations for repair measures, as appropriate. If damage occurs during the wet season, it may be necessary to postpone repair measures until the site is dry.

Invasive Species

Qualitative assessment of invasive species in non-focal-species vernal pools and surrounding upland watershed is separate from the nonnative cover evaluation performed during quantitative monitoring. The purpose of the qualitative assessment is to identify any serious invasive species issues so they can be addressed immediately. Certain invasive animal species (bullfrogs, gophers, and others), plant species identified as “High” on the California Invasive Plant Council’s Invasive Plant Inventory (Cal-IPC 2007), and other highly invasive exotics that are problematic to vernal pools (e.g., *Agrostis avenacea*) will warrant prompt response.

Inundation

A pool occupied by focal shrimp species must inundate at a depth of 3 cm or more at least once in 3 years that have 65% average rainfall. If this does not occur, the complex will be elevated to Monitoring and Management Level 2.

3.3 QUANTITATIVE THREAT TRIGGERS

The required management level (Level 1, 2, or 3) for each complex within the Preserve will be determined by evaluating monitoring results against the VPMMP standards outlined in Section 1.5. The triggers for each management level described below will determine if a complex level should be elevated or lowered based on consistency with the VPMMP standards (refer to Figure 1-1).

It is assumed that any observed decline in focal plant species (decline in cover class) or focal faunal species (decline in species density) is evidence of a decline in population viability for those focal species within a given complex. The goal is to detect population decline early. Thus, the VPMMP standards are intended to identify initial changes in populations. It is possible that early changes in a population could be a factor of seasonal weather patterns and annual variability. The requirement for 3 years of data collection from seasons with adequate rainfall to evaluate the VPMMP standards for a given complex will minimize the effects of seasonal and annual variability on monitoring data results. If a decline in population viability is detected early within a complex, efforts needed to enhance and restore the degraded habitat will be minimized.

3.3.1 Level 1 Triggers

Level 1 is considered the minimum requirement for monitoring and management (i.e., stewardship); thus, there are no specific triggers for a complex to be monitored or managed at this level. A Level 1 complex will remain at Level 1 in perpetuity unless the Level 2 (Section 3.3.2) or Level 3 (Section 3.3.3) triggers are met.

3.3.2 Level 2 Triggers

The assessment's results from monitoring (for a complex at either Level 1 or Level 3) will determine if a complex should be elevated or reduced to Level 2. Complexes will remain at Level 2 monitoring and management activities for 3 years. At the completion of 3 years, a complex can be elevated to Level 1 if the triggers for elevation are met (see below).

Triggers to Reduce a Complex to Level 2

For pools within complexes at Level 1 (see Section 2.2.3.1), the following triggers will reduce a complex to Level 2.

Focal Plant Species

- an average decline of one cover class (see Section 2.2.3) for any focal plant species present in the pools assessed over 3 years with adequate rainfall, OR
- an average increase of one cover class in combined nonnative cover in the vernal pools over 3 years, regardless of rainfall. This trigger only applies to complexes with at least 10% total nonnative cover.

Any focal plant species that triggers Level 2 will become a “target” focal plant species until management is successful at reestablishing baseline cover for that species.

Focal Shrimp Species

- a 20% decline in species density in the focal shrimp species present in the pools assessed over 3 years.

Hydrologic Function

- a change in the vernal pool hydrological network (i.e., inlet and outlet features) and water storage function such that the maximum depth of ponding is changed (increased or decreased) by more than +/-10% but less than +/-20% from the baseline recorded for the basin.

Triggers to Elevate a Complex to Level 1

A complex can be elevated from Level 2 to Level 1 if conditions improve. For pools within complexes at Level 2 (see Section 2.2.3.2), the following triggers will elevate a complex to Level 1.

Focal Plant Species

- an average increase of one cover class for ALL target focal plant species present in the pools assessed over 3 years with adequate rainfall, AND
- an average decrease of one cover class in combined nonnative cover in the vernal pools over 3 years, regardless of rainfall.

Focal Shrimp Species

- a 20% increase in species density in the focal shrimp species present in the pools assessed over 3 years.

Hydrologic Function

- through active restoration and enhancement (i.e., topographic recontouring), a reestablishment of the baseline vernal pool hydrological network and water storage function to within +/-10% of the baseline recorded for the basin.

3.3.3 Level 3 Triggers

The assessment's results from monitoring (for a complex at either Level 1 or Level 2) will determine if a complex should be reduced to Level 3. Complexes will remain at Level 3 monitoring and management activities for 5 years. At the completion of 5 years, a complex can be elevated to Level 2 or Level 1 if the triggers for elevation are met (see below).

Triggers to Reduce a Complex to Level 3

For pools within complexes at Level 1 (Section 2.2.3.1) or Level 2 (Section 2.2.3.2), the following triggers will reduce a complex to Level 3.

Focal Plant Species

- an average decline of two cover classes for any focal plant species present in the pools assessed over 3 years with adequate rainfall, OR
- an average increase of two cover classes in combined nonnative cover in the vernal pools over 3 years, regardless of rainfall. This trigger only applies to complexes with at least 10% total nonnative cover.

Any focal plant species that triggers Level 2 or Level 3 will become a “target” focal plant species until management is successful at reestablishing baseline cover for that species.

Focal Shrimp Species

- a 40% decline in species density in the focal shrimp species present in the pools assessed over 3 years.
- Additionally, if a complex has remained at Level 2 for 3 years with at least 55% of average rainfall, the complex would be elevated to Level 3 monitoring and management.

Hydrologic Function

- a change in the vernal pool hydrological network (i.e., inlet and outlet features) and water storage function such that the maximum depth of ponding is changed (increased or decreased) by +/-20% or more from the baseline recorded for the basin.

Triggers to Elevate a Complex to Level 2

A complex can be elevated from Level 3 to Level 2 if conditions improve. For pools within complexes at Level 3 (Section 2.2.3.3), the following triggers will elevate a complex to Level 2.

Focal Plant Species

- an average increase of one cover class for ALL target focal plant species present in the pools assessed over 3 years with adequate rainfall, AND
- an average decrease of one cover class in combined nonnative cover in the vernal pools over 3 years, regardless of rainfall.

Focal Shrimp Species

- a 20% increase in species density in the focal shrimp species present in the pools assessed over 3 years.

Hydrologic Function

- through active restoration and enhancement (i.e., topographic recontouring), reestablishment of the baseline vernal pool hydrological network and water storage function to less than +/-20% of the baseline recorded for the basin.

Triggers to Elevate a Complex to Level 1

A complex can be elevated from Level 3 to Level 1 if conditions improve. For pools within complexes at Level 3 (Section 2.2.3.3), the following triggers will elevate a complex to Level 1.

Focal Plant Species

- an average increase of two cover classes for ALL target focal plant species present in the pools assessed over 3 years with adequate rainfall, AND
- an average decrease of one cover class in combined nonnative cover in the vernal pools over 3 years, regardless of rainfall.

Focal Shrimp Species

- a 40% increase in species density in the focal shrimp species present in the pools assessed over 3 years with at least 55% of average rainfall.

Hydrologic Function

- through active restoration and enhancement (i.e., topographic recontouring), a reestablishment of the baseline vernal pool hydrological network and water storage function to within +/-10% of the baseline recorded for the basin.

CHAPTER 4

TIERED MANAGEMENT APPROACH

4.1 MANAGEMENT LEVEL GOALS

The VPMMP includes three management levels that correspond to the VPHCP conservation goals for the vernal pool complexes and focal plant and animal species, with an optional fourth goal. The management level for any given complex depends on the condition of the vernal pool habitat and the status of the focal species populations within that complex. The goals of the three management levels, and one optional fourth goal, for the VPMMP are as follows:

- Management Level 1: *maintain* existing habitat conditions and existing focal species population status (i.e., stewardship).
- Management Level 2: *stabilize* habitat conditions and focal species populations.
- Management Level 3: *remediate* habitat conditions and focal species populations to baseline conditions defined by the City's Vernal Pool Inventory (2004).
- A fourth goal is to *expand* habitat conditions and focal species populations, where appropriate. This goal is not part of the required management actions for the VPHCP Preserve, and will require grants and other types of alternative funding sources for implementation. Refer to Chapter 5 for more detail.

4.2 MANAGEMENT BACKGROUND AND RATIONALE

Management of vernal pool habitats in Southern California dates back more than 20 years and has ranged from simple site protection to fully developed vernal pool habitat restoration and enhancement. Some of the earliest City sites to be actively managed with habitat restoration and enhancement were Del Mar Mesa (H1-15), Lopez Ridge (B5-8), and General Dynamics (N8).

Until the mid-1990s, vernal pool habitat restoration was considered to be an uncertain method of conservation and preservation for the focal vernal pool species. Beginning in the mid-1990s, multiple vernal pool management programs were implemented on existing or future City lands. These programs were more aggressive in the scope and level of effort than previous restoration programs. The goal of such programs was to stabilize, remediate, and expand vernal pool habitat and the focal species populations. Projects were implemented on a number of sites throughout the City, including Greystone Torrey Highlands (H39), Robinhood Ridge (J4), West Otay A, B,

and C (J32), and Cal Terraces (J2S and J2N). Most recently, a TransNet-funded restoration program was implemented at Otay Lakes (K5), Marron Valley (MM1), Nobel Drive (X5), and Goat Mesa (J16-18) to address focal species population decline or extirpation noted during MSCP monitoring. This program was successful at stabilizing and reestablishing focal species populations during the 3-year timeframe. However, these sites need continued maintenance for focal species populations to remain stable.

Based on the known successes of vernal pool habitat restoration efforts in Southern California, there is strong evidence that habitat restoration and enhancement can achieve the VPMMP conservation goals discussed in Section 4.1.

4.3 IMPLEMENTATION OF MANAGEMENT LEVELS

As discussed above, Monitoring Level 1 and Management Level 1 are considered the minimum requirement unless baseline conditions warrant a higher level (see Chapter 3). Monitoring Level 1 will determine if higher level triggers have been met, at which point a complex will be elevated to a higher management level. Likewise, Monitoring Level 2 and Level 3 will determine if a complex should be moved to a higher or lower management level (see Figure 1-1). Monitoring levels are discussed in Chapter 2 and management levels are discussed below.

Because of seasonal climate variability and resulting effects on the expression of both invasive species (weed germination, flowering, and seed-set; dispersal of invasive animals; etc.) and focal species (plant germination, flowering, and seed-set; shrimp hatching, development, and reproduction; etc.), the activities described below will be applied for a minimum of 3 years for Level 2 and 5 years for Level 3. If, after 3 or 5 years of implementation of Management Level 2 or Level 3, respectively, the complex is still triggering the same management level, then the respective management level will continue until the complex meets the respective trigger thresholds.

Selected management activities within a particular management level will be implemented at a particular complex based on site needs. Management activities deemed necessary based on monitoring observations (Chapter 2) are assumed to be implemented within the same season, if feasible. For management actions that are seasonally dependent (e.g., topographic reconstruction must be performed outside of the rainy season), it is assumed that implementation will occur during the next appropriate season (e.g., the dry season). These management activities will be detailed further in the City's complex-specific management directives (currently being prepared). Management levels were assigned to each complex based on a review of existing available quantitative and qualitative data to determine site status and management needs. Limited

quantitative data has been collected on complexes within the Preserve since the baseline data was collected in 2002/2003. For the majority of the complexes, only qualitative information was available for the initial management level assessment. Qualitative information and input was provided by senior biologists and local experts from SANDAG SB, USFWS, the City, and AECOM who are most familiar with vernal pool habitat and management in San Diego. These experts have observed qualitative changes in focal species populations, general vernal pool habitat quality, and other site conditions over the last 10 years. The local vernal pool experts used available qualitative data to collaboratively determine the appropriate management level when quantitative data was unavailable or incomplete. Quantitative and qualitative data were evaluated and compared to the management level triggers described in Sections 3.2 and 3.3.

4.3.1 Management Level 1

The goal of Management Level 1 is to *maintain* existing habitat conditions and existing focal species population status.

Management Level 1 is the minimum requirement for all vernal pool complexes within the Preserve subject to the City's jurisdiction. The need to conduct these management activities will be assessed through qualitative and quantitative monitoring. General management activities that will be required for every complex annually are described below. It is assumed that routine access patrol and enforcement will occur at all Level 1 sites. Access patrol visits will occur annually, at a minimum, at each site, or more frequency (e.g., monthly, weekly) as deemed appropriate by the City.

Trash and Debris Removal

All complexes will be kept free of trash and debris through annual or as-needed removal.

Fencing and Signage Maintenance

Every complex will be protected with site-appropriate fencing, vehicle barriers, and/or other access controls. Any complex without adequate protection will be fenced or protected by other types of access barriers.

Status of access restrictions will be documented as part of the qualitative monitoring. If problems are identified, recommendations for repair or replacement will be made and implemented (e.g., replacement of locks, gates, or signs, or fence repairs).

Edge Effects Maintenance

Recommendations for addressing edge effects that are noted during qualitative monitoring will be implemented. This may include changes in irrigation designs or schedules, modification of landscape species, erosion-control measures, dust-suppression measures, and other adaptive efforts.

Fire and Fire Suppression Damage Repair

If a complex is affected by fire, there are general expectations for recovery and invasion by weeds (see Section 3.2). Any damage that is a result of fire suppression (fencing damage, vehicle damage, contamination from fire suppressant chemicals, etc.) will be addressed immediately.

Trespass Damage Repair

During qualitative assessment, any signs of trespass will be assessed for damage. Unauthorized trails will be closed and signage installed, where appropriate. Damage that alters hydrology will be assessed and measures will be implemented to resolve the problem.

Topographic Disturbance Repair

Minor topographic damage (e.g., foot prints, small tire ruts) will be repaired with hand tools.

Focal Vernal Pool Weed Control

Focal Vernal Pool Weed Control Level 1 (two visits per spring) will be performed in vernal pools occupied by focal species to maintain acceptable nonnative cover levels.

General Weed Control

The purpose of General Weed Control Level 1 (two visits per spring) is to target invasive nonnative species that are identified during qualitative monitoring in non-focal species vernal pools and/or associated upland watersheds. The primary goals are to prevent spread of invasive nonnative species into focal species pools and eradicate problematic invasive species upon detection.

4.3.2 Management Level 2

The goal of Management Level 2 is to *stabilize* the existing habitat conditions and focal species population status.

Management Level 2 includes all activities listed for Management Level 1, plus the additional activities discussed below. The specific methods are described in Section 4.4.

Dethatching

Dethatching is recommended prior to other types of weed control. Although some complexes may require weed control without dethatching, this will be evaluated on a complex-by-complex basis. For example, dethatching is not needed to treat invasive forbs at a complex with limited thatch. For most complexes, dethatching will be applied to the basins and in a 20-foot watershed buffer around each basin. Thatch and nonnative seed control is important for both the pool and the upland watershed, as the watershed can be a major source of weed seed and nonnative thatch input.

Focal Vernal Pool Weed Control

Focal Vernal Pool Weed Control Level 2 (two visits per spring) will be conducted on the vernal pools with focal species plus a 20-foot watershed buffer. Weed control includes all aspects of invasive plant control such as hand weeding, mechanical weeding, and herbicide use. A 20-foot buffer around a pool is approximately equivalent to a 5:1 watershed-to-vernal pool area ratio (based on the average size of vernal pools in the VPHCP Preserve that have focal species). Management of the upland watershed habitat at this ratio is considered appropriate when the site needs stabilization of habitat and focal species populations.

General Weed Control

The purpose of General Weed Control Level 2 (three visits per spring) is to target invasive nonnative species that are identified during qualitative monitoring in non-focal species vernal pools and/or associated upland watersheds. The primary goals are to prevent spread of invasive nonnative species into focal species pools and to eradicate problematic invasive species upon detection.

Seed Collection/Bulking/Dispersal

Seed Collection/Bulking/Dispersal Level 2 (one greenhouse generation) will be implemented for declining focal plant species to reestablish focal species seed banks following weed control. All pools with declining focal plant species will be included in this program. While it is possible to grow more than one generation in the greenhouse in a year, it is most effective to time greenhouse planting so some container plants can be used for planting (if required) and some can be used for seed production. With this approach, it is only possible for one generation of plants to be propagated in any given year. At Management Level 2, the seed bank is assumed to still be intact, but in need of rejuvenation, so a single seed bulking event is appropriate.

Cyst Collection and Reinoculation

If quantitative monitoring indicates a decline in density of one or both focal fairy shrimp species, shrimp cyst soil may be collected from other occupied pools in the same complex for reinoculation into declining pools. Shrimp cyst soil will only be collected from pools that do not contain Lindhal's fairy shrimp. Cyst collection from off-site sources may be considered if the potential cyst bank on-site is either gone or too limited for collection.

Topographic Reconstruction

Moderate topographic disturbance that affects pool integrity, ponding potential (depth and duration), or overall size will require microtopographic repair involving mechanized equipment and hand work. Where necessary, ponding characteristics, flow patterns, and other hydrological functions will be reestablished to within +/-10% of the baseline conditions (as determined during the baseline HGM survey described in Section 2.2.2) using hand tools and/or equipment, as appropriate. A more detailed plan may be necessary for grading if equipment is used.

4.3.3 Management Level 3

The goal of Management Level 3 is to *remediate* the habitat conditions and focal species population status to baseline conditions (defined by the 2004 City Vernal Pool Inventory).

Management Level 3 includes all activities listed for Management Level 1, plus the additional activities discussed below. The specific methods are described in Section 4.4.

Dethatching

Refer to Section 4.3.2 for a discussion on implementing dethatching.

Focal Vernal Pool Weed Control

Focal Vernal Pool Weed Control Level 3 (four visits per spring) will be conducted on the vernal pools with focal species plus a 35-foot watershed buffer. A 35-foot buffer around a pool is approximately equivalent to a 10:1 watershed-to-vernal pool area ratio (based on the average size of vernal pools in the VPHCP Preserve that have focal species). Management of the upland watershed habitat at this ratio is considered appropriate when the site needs remediation of habitat and focal species populations.

General Weed Control

The purpose of General Weed Control Level 3 (four visits per spring) is to target invasive nonnative species that are identified during qualitative monitoring in non-focal species vernal pools and/or associated upland watersheds. The primary goals are to prevent spread of invasive nonnative species into focal species pools and eradicate problematic invasive species upon detection.

Seed Collection/Bulking/Dispersal

Seed Collection/Bulking/Dispersal Level 3 will involve two greenhouse generations. Seed collection from off-site sources may be considered if the potential seed bank on-site is either gone or too limited to collect from.

At Management Level 3, the seed bank is assumed limited and in need of remediation, so two seed bulking events are appropriate.

Cyst Collection/Bulking/Inoculation

If quantitative monitoring indicates a decline in density of one or both focal fairy shrimp species, shrimp cyst soil may be collected from other occupied pools in the same complex for reinoculation into declining pools. Shrimp cyst soil will only be collected from pools that do not contain Lindhal's fairy shrimp. Cyst collection from off-site sources may be considered if the potential cyst bank on-site is either gone or too limited for collection.

Container Plant Production/Installation

Under Management Level 3, container plant production will be conducted for the annual focal plant if timing is appropriate (see Section 4.4.4). One container plant installation event will occur for Management Level 3, ideally in the first year of management.

Topographic Reconstruction

Extensive topographic disturbance that affects pool integrity, ponding potential (depth and duration), or overall size will require microtopographic repair involving mechanized equipment and hand work. Where necessary, ponding characteristics, flow patterns, and other hydrological functions will be reestablished using hand tools and/or equipment, as appropriate. Hydrological function must be reestablished to within $\pm 20\%$ of the baseline conditions (see Section 2.2.2) to elevate from Management Level 3 to Management Level 2, and within $\pm 10\%$ of the baseline conditions to elevate to Management Level 1. A more detailed plan may be necessary for grading if equipment is used.

4.4 MANAGEMENT METHODS

The sections below describe the methods for the management activities at each management level.

4.4.1 Fencing and Signage

The majority of vernal pool complexes are currently fenced; however, additional fencing will be installed when necessary to properly protect the complex. The type and length of fencing at each complex will depend on site needs, which will be assessed during the qualitative site visit. Typical fence types are as follows:

- three-stranded barbless wire
- two-plank woodcrete
- ORV deterrent fencing
- 6-foot-high chain-link

Fence installation will occur outside of the avian breeding season so that installation does not disturb nesting birds or other wildlife. To the extent feasible, existing access roads will be used to minimize disturbance to habitat.

4.4.2 Weed Control

The weed control program will include dethatching as necessary, followed by herbicide and other weed control measures.

Dethatching is most appropriately performed in the winter, prior to the avian breeding season, with follow-up visits during the spring and early summer. Spring and summer herbicide application and other weed control measures (e.g., use of weed-eating equipment) will be based on rainfall patterns and the germination and development of the nonnative target species at each complex, not on a predetermined schedule.

Dethatching

Within vernal pools and surrounding watersheds, sensitive biological resources are suppressed due to thatch accumulation. The primary purpose of dethatching is to remove nonnative biomass, exposing more soil within the vernal pool basins or upland watersheds to improve the germination of native species and reduce competition.

Dethatching is usually most effective while nonnative seed heads are still on the stalks (late spring and early summer), when seed can be effectively removed along with the thatch. Removed thatch will be transported off-site and disposed of at an appropriate facility. If dethatching takes place later in the summer or in the fall, most of the weed seed will fall to the ground. Seed can be collected using leaf blowers, which can inadvertently collect native seed as well. Collection of target native plant seed should occur prior to dethatching to minimize the removal of the native seed bank. Seed can be stored until the next growing season or put back on-site following completion of dethatching and nonnative seed removal. Dethatching also makes future weed control measures more effective and efficient by exposing germinating weed species for herbicide application.

Hand Weeding

Hand weeding is inefficient and relatively expensive, but it can minimize inadvertent impacts to focal species, the watershed, and wildlife. However, trampling and soil disturbance may occur, countering the effects of weeding. Hand weeding should only be used in vernal pools or in the upland watersheds when it can be accomplished efficiently or where other methods cannot be applied.

Weed Eating and Mowing

Weed eating and mowing can be effective tools to prevent nonnative species from flowering and reproducing. Weed eating is appropriate in the vernal pools and their surrounding watersheds, while mowing is appropriate only in the surrounding upland watersheds. A combination of weed eating and mowing can be effective and efficient if done by trained crews, especially when sensitive native plants are surrounded by larger areas of weed-dominated cover. A “high” mow should be used (i.e., no shorter than 6 to 8 inches) to prevent native species from being destroyed or damaged, and to minimize risk to ground-foraging wildlife. In general, weed eating and mowing are not a significant threat to invertebrate wildlife, as long as soil is not disturbed.

Generally, regular weed eating or mowing treatments should begin in later winter or early spring, when nonnative species are tall enough for these methods to be effective but have not yet flowered. In years with late rainfall, this timing can be pushed back to late spring. Cut material should be removed using mowing bags or hand cleanup.

Herbicide Use

Herbicide use is often the most effective method of weed control in native habitats, but it can be costly. Herbicide should be appropriate for use around aquatic invertebrates near ponded vernal pools. Misuse of herbicides can cause substantial damage to native plant species, habitats, and wildlife, especially in aquatic environments. Herbicide will only be used in the upland watershed and at least 3 feet from vernal pool habitat at all times.

Herbicide use is most effective in the earlier stages of plant germination and establishment. It is easier for herbicide applicators to avoid spraying native species early in the season, as the native and nonnative species have more spatial separation early in the growth cycles. This is especially true if the herbicide treatment area has been dethatched prior to fall/winter germination.

Application of glyphosate-based herbicides such as RoundUp or Aquamaster will be applied to targeted areas. Herbicide will only be applied when wind speed is less than 5 miles per hour and with spray nozzles designed to maximize the size of droplets to reduce potential drift. Where feasible, a 10-foot buffer will be maintained around concentrations of any sensitive plant species. Application of herbicide will not occur if rain is projected within 24 hours.

Herbicide may be sprayed or applied by hand with various specialized applicators. An herbicide wick-staff can be used to directly contact plants by hand to eliminate risk of overspray.

4.4.3 Seed Collection, Bulking, and Dispersal

When introduction of sensitive species is needed, a seed collection and bulking program may be used when the focal plant species are not commercially available.

Seed will be collected in the fall and taken to a seed bulking facility (e.g., S&S Seeds) so that seed is ready for site broadcast by the fall of the following year. No more than 10% of any given population from a given pool will be collected.

4.4.4 Container Plant Production and Installation

As discussed above for Management Level 3, container plant production and installation will be considered for declining focal plant species. Plants that are being grown in the greenhouse for seed bulking purposes will be considered for planting, but only if site conditions and seasonal rainfall are adequate.

If container plants are early in development and the timing is such that vernal pools have filled with water in the winter or early spring, a portion of these greenhouse plants will be brought to the complex and installed into the pools where the seed was originally collected. This installation of greenhouse container plants will only be conducted under these conditions and only if more rainfall is expected. It is difficult to take care of vernal pool container planting if the pools are not ponded and the soil is not saturated.

Plants will be carefully installed within the ponded basin area, working from the pool margins to reduce impacts to the pool basin. Only the annual focal plant species will be considered for container plant installation, so San Diego button-celery will not be targeted for a container planting program.

4.4.5 Topographic Reconstruction

Recontouring will involve the reshaping of mima mounds and excavation of basin areas to mimic natural vernal pool/mima mound topography for areas that have clear mound and basin topography (either currently or based on historical photographs). Recontouring may include all or some of the following methods:

- excavation/creation of new basins and contouring of new mounds using a small bulldozer or small equipment in historical mima mound fields,

-
- decompaction and recontouring of vernal pools using a small bulldozer or hand tools where equipment is not allowed, and/or
 - recontouring to remove vehicle tracks and other disturbances using a small bulldozer or hand tools where equipment is not appropriate.

If grading or excavation is required for recontouring, and the potential exists for use of mechanized equipment while maintaining and protecting focal fairy shrimp species, a grading plan may be necessary. Grading would be performed during the dry season with a bulldozer that is small enough to access and maneuver within the site. The limits of work will be indicated on the grading plan. Mima mounds that function biologically and appropriately, and that contain sensitive biological resources, will be left intact. Prior to grading, the top 1 to 2 inches will be excavated from the pool for use as topsoil. Vernal pools will be slightly overgraded (1 to 2 inches) and backfilled with collected topsoil to promote plant propagation and to preserve any vernal pool innoculum.

A final pregrading field visit will be conducted to delineate areas of cut and fill using a trail of flour and/or pin flagging. No spray paint will be used. A complete set of preconstruction photographs will be taken at this time. During a preconstruction site visit, the grading operator will be familiarized with the complex and the issues involved.

Areas to be manipulated with grading equipment or hand tools will be graded before the saturation of soils. Site grading and construction of mima mounds will be performed by using no less than one-third of the cut soil as fill material for mima mounds (0.3:1), and fill will be balanced to avoid off-site export of usable soil when possible. Work will be monitored with a laser transit to ensure that the design is followed and that the depths and flow patterns are correctly maintained or modified.

4.4.6 Restoration and Management Plan

For certain complexes, a detailed Restoration and Management Plan (RMP) may be necessary to direct implementation of management activities. The need for an RMP will be determined based on the complex management recommendations and/or current regulatory requirements that apply to a specific complex.

An RPM will discuss the goals and objectives of habitat management and identify specific requirements to maintain, stabilize, and/or remediate the focal species that are known from a

particular complex, consistent with the VPMMP. An RPM may include the following information and implementation guidance:

- Fencing and signage installation or repair requirements, including any additional access-related issues
- Directives, methods, and scheduling for dethatching, hand weeding, mowing (including line trimming), and herbicide use (methods and limitations)
- Specifications for seed collection, seed bulking, and seed dispersal, including methods and limitations
- Specifications for container plant production and installation, including methods for growing and planting, methods for plant care, and limitations
- Directives for evaluating, planning, and implementing topographic reconstruction, potentially including detailed microtopographic mapping and design
- Annual and final 5-year success criteria for evaluating progress and final success of restoration efforts

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CHAPTER 5

DESIRED ACTIONS

This chapter recommends additional actions (beyond those required by the VPHCP) that may *expand* the focal species populations (the optional fourth goal of the VPMMP) at individual complexes or provide valuable information on associated ecological factors. These desired actions are not required for implementation of the VPHCP, but could be implemented separately if and when additional funding and resources become available. Desired actions are categorized into three topics: research, data collection and analysis, and restoration of historical vernal pool habitat.

5.1 RESEARCH

Options for research efforts to better understand focal species population dynamics include the following:

- Develop and test a methodology to better estimate population density or population size for fairy shrimp. This study would help to resolve the current lack of quality data collected from USFWS protocols for fairy shrimp population estimates. Improved data quality would allow for more accurate monitoring of management activities for fairy shrimp under the VPMMP.
- Conduct studies to determine the extent of hybridization with versatile fairy shrimp and its effects on San Diego fairy shrimp reproduction, population genetics, and viability.
- Conduct genetic studies for fairy shrimp to better understand population genetics and the relationships between and among vernal pool complexes (see discussion below).
- Research the relationship between focal plant and fairy shrimp presence and/or densities to better understand which species, or assemblage of species, are the best for use in habitat-quality evaluation benchmarks.
- Research which pollinators are important to each of the focal species, where these pollinators occur, and how these species can be targeted in habitat restoration and management.

SANDAG SB is currently funding research on the genetics, hybridization, and conservation of San Diego fairy shrimp. The research project is being conducted by Dr. Andy Bohonak at San Diego State University and will include the following tasks:

- Evaluation of San Diego fairy shrimp genetics at the landscape level by quantifying the genetic variation across the species range for individuals, within pools, and within complexes. This will include an interpretation of the genetic patterns in terms of landscape connectivity, disturbance, recreational activities, and other environmental parameters. Microsatellite markers will be developed to provide insight of the biological meaning of the two potential clades identified in Dr. Bohonak's mitochondrial DNA research of the species.
- Determination of the level of hybridization between San Diego fairy shrimp and versatile fairy shrimp by developing and applying morphological and genetic hybrid indices to the two species across Southern California. This will include a morphological review of historic vouchered specimens.
- From the results of the first two tasks, provide recommendations for management, conservation, and mitigation in term of impacts on the genetic integrity and recovery of San Diego fairy shrimp.

5.2 DATA COLLECTION AND ANALYSIS

Options for data collection and analysis efforts to better understand focal species population dynamics include the following:

- Perform vernal pool monitoring using the CRAM Vernal Pool Module. CRAM is a state-wide program that looks at various wetland types across California, and it is important to incorporate the City's vernal pool data into the state-wide CRAM database.
- Perform vernal pool monitoring using the HGM approach. While the data collection methods for the focal plant species can be used in the HGM evaluation, the focal shrimp species data collection methods are not adequate for this model. Collection of HGM-level crustacean data will provide key information for use in an HGM model, providing another method for habitat evaluation and adding to the HGM model database.
- Perform long-term trend analysis on vernal pool complex monitoring data to develop individualized monitoring and management triggers for each complex to allow for

complex differences that are not being evaluated with the current methods (i.e., universal triggers for all VPHCP complexes).

5.3 RESTORATION OF HISTORICAL VERNAL POOLS AND FOCAL SPECIES POPULATIONS

5.3.1 Restoration of Historical Vernal Pools

This desired action would involve review of historical records and aerial photography to determine historical locations of vernal pools within preserved complexes. Vernal pools would be restored to mimic historical site conditions and placed where past pools were known to exist (not where pools currently exist). This would require development of a detailed restoration plan to be approved by USFWS, as well as obtaining necessary City permits and approvals. Depending on site conditions, restoration activities would be similar to those described under Management Level 3, except more specific emphasis would be placed on the expansion of existing focal species populations into historical habitat through restoration and creation.

5.3.2 Restoration of Historical Focal Species Populations

This desired action would involve reestablishing historical focal species populations that have been (or are thought to be) extirpated from a complex. Historical data (i.e., previous to the 2004 baseline data established for the VPHCP) and available documentation would be reviewed to identify specific pools in a complex with historical focal species populations that are thought to be extirpated. Reestablishment of focal species in a pool would involve a program of seed collection and bulking, and container plant propagation and installation, similar to the activities described under Management Level 3.

Table 5-1 lists the complexes that should be considered for reestablishment of focal species populations, based on the USFWS Recovery Plan (1998), the City's Vernal Pool Inventory (2004), and AECOM's knowledge of historical occurrences in San Diego.

Table 5-1
Vernal Pool Complexes to Consider for Focal Species Population Reestablishment

Complex ID	Name	Species for Reestablishment
J11E	Slump Block Pools	ORCA
J11W	J11 West	STWO
J12	J12	ORCA, ERAR
J13E	J13 East	ORCA
J14	905, Anderprises, Bachman, Brown Field Basins,	NAFO, ERAR, PONU

ERAR = San Diego button-celery; NAFO = spreading navarretia; ORCA = California Orcutt grass; PONU = Otay Mesa mint; STWO = Riverside fairy shrimp

CHAPTER 6

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ATTACHMENT A
VERNAL POOL COMPLEX
MONITORING FORM

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Continue on back if needed.

Modified Trudgen & Keighery Vegetation Condition Scale

Very Good-Excellent	80-100% Native Flora Composition Vegetation Structure intact or nearly so Cover /abundance of weeds < 5% No or minimal signs of disturbance
Fair to Good	50-80% Native Flora Composition Vegetation structure modified or somewhat modified Cover/abundance of weeds 5-20% any number of individuals Possible minor signs of disturbance
Poor	20-50% Native Flora Composition Vegetation structure modified Cover/abundance of weeds 20-60% any number of individuals Disturbance incidence high
Very Poor	0-20% Native Flora Composition Vegetation Structure disappeared Cover/abundance of weeds 60-80% any number of individuals Disturbance incidence very high

Disturbance Categories and Descriptions (Bauder et al. 2009)

- 1 Minimal disturbance/no disturbance**
no known disturbance
light past grazing or brushing
ungraded tracks or trails
- 2 Light to moderate disturbance --not recent, self-recovered or restorable**
brushing, blading, disking, cultivation and/or vehicles (not recent)
grazing
trash/dumping
fire
sediment deposition
- 3 Moderate to substantial disturbance --restorable or has been restored; some potential for self-recovery**
disking, blading and/or plowing (cultivation)- may or may not be recent
sediment deposition
vehicle damage
landscape altered by roads, culverts, and/or loss of mounds
- 4 Substantial disturbance--restoration potential, but extensive restoration efforts needed**
on-going grazing, frequent fires and/or recent blading/brushing
extensive vehicle damage
landscape altered by roads, culverts, and/or loss of mounds
past extensive blading, bulldozing, plowing (cultivation) or grading
- 5 Substantial disturbance--developed or restoration potential low**
blading, grading, trenching or filling
extensive development with hard surfaces, roads, culverts
severe or ongoing disturbance (brushing, blading, disking, grading, bulldozing, irrigation, cultivation, vehicles)
- 6 Severe disturbance--surrounding landscape dominated by development, restoration potential minimal to none**
deep blading, extensive trenching or ripping
native soil profile no longer evident
artificial landscape dominates, either hard surface or cultivated turf and landscaping
few or no vestiges of the natural topography